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## STILT-WALKERS.

By E. A. BUTLER, B.A., B.SC.

THE order of insects which is known as Rhynchota (beaked), or Hemiptera and Homoptera, and popularly called "field-bugs," contains many extraordinary forms remarkable for the extreme modification to which one or more of the organs of the body have been subjected. Some particular line of development has been followed to such an extent that it seems impossible to imagine any further modification in the same direction; the climax has been reached, and the possibility of any advance beyond it seems to be barred by the mere physical conditions of existence. The parts that possess the greatest plasticity appear to be the thorax, the legs, and the antennæ. While the most noteworthy developments are seen, as might be expected, in exotic species, our own country furnishes in this order at least one small and interesting collection of insects exemplifying a tendency of the kind referred to. From different families of the British Hemiptera we may select a group of species which have attained in their legs and antennæ the highest degree of length and tenuity that seems compatible with the preservation of these organs at all. Of course a considerable reduction in the thickness of the body has been brought about at the same time, otherwise it would have been too heavy to be supported by the attenuated legs. As these examples belong to several distinct families, it is evident that their slenderness has been independently acquired, and hence we have in these stilt-walkers a good instance of parallel development. Since the insects are absolutely unknown to any but professed entomologists, they have no popular names, and hence, in speaking of them, I am compelled to use their somewhat cumbrous scientific names.

As the first example of this spectral group we will take the insect called *Metatropis rufescens* (Fig. 1). This is by no means a common insect, though when it does occur it can usually be found in some numbers. It is a vegetable feeder, and is specially attached to the plant called "Enchanter's nightshade" (*Circæa lutetiana*), the juices of which it sucks through its slender beak. The plant is an abundant weed in shady places, but the insect is not more than a very occasional accompaniment of it. It is an exceedingly elegant species, with a narrow body of a reddish yellow colour, about five-eighths of an inch long. The thorax rises into a strong hump behind, and is ornamented and, no doubt, strengthened with three prominent keels, like buttresses, one in the middle and one at each side. Behind the thorax the body suddenly narrows and shows a pinched-in waist. The thighs of all the legs are swollen at the tip, or, in other words, end in a club. This is also the case with the first joint of the antennæ, while the terminal joint is wholly swollen and club-like. These clubbed thighs and antennæ are entirely characteristic of the family to which the insect belongs. All these appendages are pale-coloured, and their whole length is thickly spotted with black. The legs end in very small feet, each of which, notwithstanding its minuteness, consists of three joints, and these six minute objects are the only parts that are in contact with the ground.

Such is the insect which may be found in late summer standing on, or walking over, the leaves of the enchanter's

FIG. 1.—*Metatropis rufescens.*

FIG. 2.—*Metacanthus punctipes.*

nightshade, keeping its body well up off the leaf, slung up, as it were, on its six hair-like legs, which act as so many springs. The antennæ, being so much like the legs in both shape and adornment, give the insect the appearance of an eight-legged creature such as a spider, though the length

of the body somewhat interferes with the deceptiveness of the appearance. The legs are so extremely thin as to be visible with difficulty at a little distance, when the insect is resting upon the leaves of its food-plant, though they stand out plainly enough when viewed against a background of white card, as would be the case in a collector's cabinet. It is doubtful, therefore, whether the insect is to any extent benefited by its superficial resemblance to a carnivorous and dangerous animal such as a spider. The enchanter's nightshade often grows under beech trees, and the reddish yellow bud-scales of these, as they fall from the tree, may often be seen lying on the leaves of the plant, in which position they look much like the body of *Metatropis*, but this again may be nothing more than an accidental resemblance. There would seem to be two advantages connected with length and slenderness of legs. As already stated, they are practically invisible except at close quarters, and they give, of course, a longer stride, enabling the insect to traverse a fairly long distance in a short time without proceeding at any great speed. But, as *Metatropis* does not appear to wander much, remaining all its life in close association with its food-plant, this last property can hardly be of much service to it.

Another member of the same family is *Metacanthus punctipes* (Fig. 2), a much commoner insect, which can usually be found in sandy places, wherever the rest-harrow, with its pretty pink pea-like flowers, grows. It is a much smaller insect than the preceding, and from the absence of colour in its wings, looks a good deal like a gnat. Anyone who wants to find this curious creature should select a luxuriant patch of rest-harrow on sandy soil in July, August or September. If the outlying branches be lifted up, the probabilities are that *Metacanthus* will be seen in numbers underneath, perhaps both the green larvæ and the greyish looking perfect insect being present together. Under the microscope this is really a very pretty insect; its black head and red neck contrast finely with the yellow thorax with its two black patches in front, and its black-tipped keels. The triangular hinder part of the thorax, or scutellum, carries a curious curved spine, the use of which can only be conjectured. In other respects this insect is like a small edition of the preceding one. Like *Metatropis* it is always found in close association with its food-plant, upon the juices of which it subsists. These two insects very well illustrate the close connection that so often exists between the vegetable and animal worlds; they are natural parasites upon their special food-plants, and their fortunes are entirely dependent upon that of the plants.

Closely allied to these two, and with even narrower body and finer legs, is *Neides tipularius* (Fig. 3). It is a yellowish grey insect, about the size of *Metatropis*, with the same clubbed legs and antennæ, and the same minute feet, but without the black spots on legs and antennæ. Unlike the other two, it does not seem to be attached to any particular food-plant, and indeed is seldom found otherwise than singly and promiscuously. It frequents heathy and sandy places, and may sometimes be discovered lurking under dead leaves, or at the roots of plants in such situations, as well as on the plants themselves. Its sandy colour, and its general slenderness of build, make it difficult to detect when on the ground, provided it has the wisdom to remain still. If it moves, its comparatively large size at once betrays it.

For our next example of stilt-walkers we must go to quite another family, in which we shall find considerable difference in structure as well as in habits, though with the same slenderness of build, or rather with the slenderness accentuated. The best example is *Ploiaria vagabunda* (Fig. 4), which, if we exclude the numerous species of gnats and their allies in the order Diptera, is unquestionably the most delicate insect in our British fauna. All the clubs have practically disappeared from both legs and antennæ, and these have, in their slenderest parts, become considerably finer than human hairs, as may easily be seen by placing a hair beside them. Fine though they are, let it be remembered that they are tubes, carrying within

Fig. 3.—*Neides tipularius.*

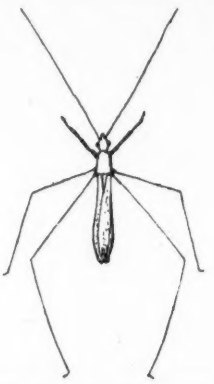

Fig. 4.—*Ploiaria vagabunda.*

them the muscles required for locomotion. Both legs and antennæ are beautifully adorned throughout their length with black rings placed at intervals, and are set throughout with long hairs, which, of course, are much finer than the legs to which they are attached, and are quite invisible to the naked eye. Concurrently with the reduction in the thickness of legs and antennæ, there has been a proportionate lessening of the length of the foot, which is about as short as it could well be. Only two pairs of legs partake of this elongation; the front pair are short, and comparatively stout, and they are noteworthy for the unusual length of their basal joints or coxæ, which, instead of being embedded as usual in the general armature of the body, project considerably, and so give the legs greater freedom of motion. These legs are used for predatory purposes, for the insect, though of so delicate a structure, is strictly carnivorous in habits, feeding upon the juices of other insects, which it catches with these legs. The sucking beak, or rostrum, as usual in this particular family, is short and curved under the head, but not laid close against the breast, as is the case in most other Hemiptera. The upper wings are beautifully mottled with dark grey, making an exquisite pattern like that of grey marble. The hinder part of the thorax carries two long spines, one behind the other, while a third appears at the base of the abdomen. The eyes are very prominent, and the insects have unquestionably good powers of vision, as might be expected from their carnivorous instincts.

These exquisite insects are to be found in all sorts of localities. Often they occur on trees, especially oak and fir, but perhaps ivy and holly are as attractive as anything to them. Of course these trees are frequented not for their own sakes, but on account of the other insects which they harbour. On one occasion I found a large assemblage of them on some oaken palings. Such palings are well known to entomologists as good hunting grounds, and *Ploiaria* had no doubt in this instance discovered the same fact. Although they occur on such trees as above, often in considerable numbers, it would be quite useless to search the branches for them, as their grey colour and extreme slenderness make them quite invisible in such situations. If the branches be shaken or tapped over a sheet or some other clear surface, the insects will easily

fall from their perches on to the receptacle awaiting them. But even then it is not easy to see them, and sometimes one finds that one has been looking straight at a specimen without noticing it, till it began to move, and then the eye has become conscious of a sort of faint shifting cloud or shadow, which at last resolves itself into the outlines of an insect. *Ploiaria* is therefore excellently protected. It is almost invisible, at least to human vision, and even when it is seen, it is found to be coloured like a bit of lichen, such as might be found in similar situations; again, like the rest of the order, it has a gland for the secretion of a fluid which probably renders it distasteful, and even if any creature did essay to eat it, it would be hardly worth the trouble, and would prove a very unsatisfactory morsel, as there is so small an amount of matter in the body, and the hair-like legs and antennæ would probably get in the way.

There are two other British species of this extraordinary genus, both of which are much smaller insects, though with equally slender legs and antennæ. The commoner of the two is found not unfrequently in thatch, where no doubt it has a fine time amongst the immense numbers of small insects of every description that delight to congregate in such places, finding thus abundance of prey, with but little trouble to itself. It is about the size and somewhat of the appearance of a gnat, whence the name *culiciformis*, or gnat-shaped, given to it.

To find our next example of these stilt-walkers we must go to the banks of a weedy pond, and here again good eyes will be needed to detect the object of our quest, for we may be looking straight at half a dozen of them and yet not see them until they move. The insect we are in search of is a sooty black one, called *Hydrometra stagnorum* (Fig. 5), a representative of a third family quite distinct from either of the other two, but still exhibiting the same degree of slenderness in both legs and antennæ, though these are not quite so long as in the other instances. It will be found either parading the muddy banks under the shelter of the weeds, or walking on the flat leaves of the water plants as they float on the surface. It is one of a very few insects that have solved the difficult problem of walking upon the water, moving its legs in the same way as when on land, and not with a skating or swimming movement such as is adopted by its relatives.

FIG. 5.—*Hydrometra stagnorum.*

FIG. 6.—*Ranatra linearis.*

It moves equally fearlessly whether along the muddy banks, over the floating leaves of the water weeds, or on the water itself, stepping from the one element to the other with the utmost confidence, and not even wetting its feet in the process. The practicability of this feat no doubt depends upon the extreme slenderness and consequent lightness of the insect, its weight being insufficient to break through the surface tension of even so mobile a liquid as water. Though capable of walking on the water, it never gets far away from the water weeds, and would probably feel itself somewhat lost if it were suddenly transferred to the midst of a broad sheet of water.

If by accident it should become immersed and so get its legs wetted, it finds great difficulty in regaining its position. A specimen which I once watched under these circumstances tried to get out upon the leaves by thrusting its legs above the water close to the edge of the leaf. But each of the fine hair-like limbs, as it emerged from the water, drew out with it a thin film of the liquid which greatly hampered its movements, and evidently needed a hard struggle to get rid of. When at last it had got clear and had apparently escaped from the troubles of capillarity, it was unable for some hours to venture on the water again; each time it attempted to do so, its minute feet gradually slid outwards, and its legs, giving way beneath it, left the poor creature sprawling upon the surface in a perfectly helpless condition. By refraining for some hours from trusting itself to the treacherous element, it ultimately recovered its power, and was able to walk about over the water as freely as before.

One of the strangest features in the organization of this insect is the great elongation of its head, which has evidently been subjected to the same lengthening influences as have operated upon the rest of its anatomy. It projects far in front of the eyes, forming a long snout which broadens at the end. There is almost an equal amount of the head behind the eyes, so that the whole head forms nearly one-third of the length of the insect. Unlike the preceding examples, this insect is scarcely ever met with in a winged condition, both pairs of wings being, as a rule, aborted.

Our last example of these stilt-walkers shall be the insect called *Ranatra linearis* (Fig. 6), one of the so-called water-scorpions, and a member of a family of Hemiptera which is very distinct from all of those already mentioned. One of the most noteworthy distinctions is that the antennæ, which hitherto have been very long, are here quite minute, and are practically invisible unless specially searched for, through being concealed by habitually lying in a depression. This particular water scorpion is not a very common species, and as it lives at the bottom of weedy ponds, only occasionally coming to the surface, it is scarcely ever seen unless caught in a net, or secured by dragging the weeds out of the pond. It is a large insect, far exceeding the dimensions of our other examples, and therefore, of course, its legs, though still very slender for a creature of such size, are not absolutely so thin as in the previous instances. They are, however, sufficiently stilt-like, both in shape and in use, to warrant our including their possessor amongst the subjects of this paper. These thin legs, of course, offer very little resistance to the water as *Ranatra* moves about at the bottom of its pond, or amongst the water-weeds. Anyone who is accustomed to sea-bathing, and knows by experience how laborious a process the human being with his thick legs finds it to make his way on foot through the water, will appreciate the advantage conferred upon *Ranatra* by its spindle-shanks, and hence we see a distinct line along which natural selection may have proceeded in producing so extraordinary an insect. From the figure it will be observed that only two of the three pairs of legs have been modified in this particular way. The front pair have reached a degree of specialization which is even more remarkable. Here the tendency to elongation has been

felt in two sections of the legs only, the others being almost dwarfed in proportion to these. The basal joint, or coxa, which, as already pointed out under *Ploiaria*, is usually embedded in the general armature of the body, is here attached by one end only, and is elongated so much as to project far in front of the head. It thus forms a sort of handle, on to which is attached so much of the leg as we generally see projecting from the body. Thus great freedom is secured in the movements of the legs, which are eminently adapted to the predatory operations in which they are concerned. The raptorial character of the leg is further conditioned by the elongation of the thigh and the dwarfing of the tibia and tarsus; the latter two parts are together no more than half the length of the thigh, and they fold back upon it, fitting into a groove along its edge, and so constituting a gripping instrument for the seizure of prey, and presenting that superficial resemblance to the claws of a scorpion, which has suggested the popular name of the insect.

Alike as all these insects are in the length and slenderness of their legs, and in the stilt-like appearance this produces in walking, we are not to regard these resemblances as indicating close relationship. The insects, in fact, do not form a natural group, but, as we have already seen, they belong to at least four distinct families, and the peculiarity of their configuration and development appears perhaps more striking when they are seen, not all grouped together as in this paper, but placed in their proper zoological position amidst the rest of the species of their order, with insects of quite normal form on both sides of them. The order Hemiptera, as a whole, is never indeed noted for thickness of legs, but still these particular species have carried the general tendency to a far greater extreme than the rest of the order, and indeed one can hardly imagine the possibility of any further development in the same direction. And, further, except one section of the order Diptera, there is no other order of British insects that can show similar extremes of development. It is remarkable too, under what diversity of circumstances this similarity of form has been acquired; for, as we have seen, some of our examples are inhabitants of the land, and some of the water; some are vegetarian, others carnivorous; and of those that are vegetarian, some are attached to particular plants, while others are general feeders; some, again, are habitually winged, others habitually apterous, and so on.

## THE ANCIENT WILD OX OF EUROPE, AND ITS LIVING REPRESENTATIVES.

By R. Lydekker.

Among many losses attributable, directly or indirectly, to the first French revolution appears to be one which is absolutely irretrievable, and must ever remain a source of the deepest regret to the naturalist. Up to that time there were preserved in Alsace two huge horns commonly reputed to belong to the great extinct wild ox of Europe. The one was preserved in the cathedral at Strassburg, the other in the episcopal palace at the neighbouring town of Zabern, or Saverne. The former was of great length ($6\frac{1}{2}$ feet), and comparatively slender, while the second (which was mounted with silver and used as a drinking-horn) was also very large and apparently stouter. Its length is not given, but its capacity was so great that it would hold four litres of wine.

The French naturalist, Buffon, who saw the Strassburg specimen, believed that it was truly the horn of a wild ox, or aurochs, but this opinion is disputed by Prof. Nehring, of Berlin, who, on account of its great length and slenderness, considers that it belonged to a domesticated Hungarian bullock. This is confirmed by an ancient tradition that the horn in question was that of one of the oxen employed in carting stones for building the cathedral, and Dr. Nehring's view may accordingly be accepted.

On the other hand, the Zabern horn, whose capacity, as already said, was four litres, may, in the opinion of the same authority, be confidently regarded as that of an aurochs. For if it be assumed that its capacity has been somewhat enlarged by shaving away the inner surface, it would seem to accord fairly well in size with large fossil specimens of the bony horn-cores of that animal. For three centuries the Zabern horn was the emblem of an association known as "the brotherhood of the horn." This society was founded in May, 1586, by Bishop John von Manderscheid, who came into possession of the horn as a hunting trophy, or heirloom, from his ancestors. The meeting-place of the society was the castle of Hoh-Barr, near Zabern. The horn was regarded with great veneration by the members of the confraternity, to which distinguished strangers were occasionally admitted as "honorary members." Like the Strassburg ox-horn, the Zabern aurochs-horn mysteriously disappeared during or soon after the French revolution.

With its disappearance vanished apparently the last relic of an aurochs killed within the historic period. It is true that Prof. W. B. Dawkins* has stated that a pair of aurochs-horns were borne in procession on certain occasions in the canton of Uri, Switzerland, so late as about the year 1866, but I am unable to find evidence that the practice is continued, or that the horns are still in existence.

In the middle ages aurochs-horns were commonly preserved—although even then as rarities—in churches and castles, where they were generally used as drinking-vessels; and it is mentioned in the *Commentaries* of Julius Cæsar, that even in his time, such horns, mounted in silver, were employed for the same purpose. In the year 1550, Conrad Gesner mentions that an entire aurochs-skull (apparently with the horns) was preserved in the town-hall at Worms, and another at Mayence. Probably both have long since perished.

Seeing that horns are almost unknown in a fossil state, it might well have been thought that, with the loss of the historic Zabern specimen, the last example of an aurochs-horn had disappeared for ever. By a lucky chance, a nearly perfect horn of the wild ox has, however, been recently discovered in a peat-bog in Pomerania, together with a fragment of the bony horn-core on which it was supported during life. The specimen has been described by Dr. Nehring, and proved to belong unquestionably to the aurochs, as distinct from the bison.

The mention of both aurochs and bison in the preceding sentence, renders it desirable to allude to a matter which has been the cause of considerable confusion and misconception. Until within the last few years, nearly all naturalists regarded these two names as synonymous, and applied them both to the bison; or rather, in many cases dropped the latter name altogether, and miscalled the animal to which it belongs the aurochs. The same practice is largely followed by sportsmen at the present day. In old German the wild ox appears to have been called indifferently either *ur* or *auerоch*; the former name being Latinised by Cæsar into *Urus*. *Auerochs*, according to the usual interpretation, signifies mountain, or wild ox; but opinions differ as to whether *ur* has a similar meaning, or

* *Quart. Journ. Geol. Soc.*, Vol. XXII., p. 393.

whether it signifies the old or primeval ox. Be this as it may, the wild ox, which may even in Cæsar's time have been growing scarce, gradually became rarer and rarer during the middle ages, till it finally disappeared in the first half of the seventeenth century. The name, however, still remained among the peasantry of Eastern Europe, and as there was no species to which it could possibly apply save the bison, which then still survived in Poland and elsewhere, it was transferred to that animal, of which, as already mentioned, it became the common designation. A precisely analogous instance has occurred in Eastern Russia. The bison, in place of being restricted, as now, to Lithuania and the Caucasus, was formerly much more widely distributed. When it disappeared from certain districts, its name still survived, and became transferred by the peasants to the eastern race of the red deer, as the only large wild ungulate with which they were acquainted.

As regards the gradual extermination of the aurochs as a wild animal during the middle ages, much important evidence has been collected of late years by Messrs. Nehring and Schiemenz.

During the Pleistocene epoch, when the mammoth and the woolly rhinoceros inhabited the British Islands and the Continent (which were then one), the aurochs was a common animal, as is attested by the abundance of its remains in formations of that age. Some of the finest and largest skulls of this so-called *Bos primigenius* were obtained by the late Sir Antonio Brady from the brick-earths of Ilford, in Essex. Other skulls have been obtained from the peat of Perthshire, from Burwell Fen, Cambridgeshire, and from a peaty deposit at Newbury, in Berkshire. A skull from Burwell Fen, in the Woodwardian Museum, at Cambridge, has a flint-implement embedded in the forehead, thus showing that the animal was hunted by the Prehistoric inhabitants of our islands at a time when the mammoth and rhinoceros had already disappeared.

As to the date of the extermination of the wild aurochs in Britain there is no decisive evidence, but no skulls or other remains have hitherto been identified from deposits of Roman or later age. It is, of course, possible that it may have survived till the epoch in question, or later, in the more remote parts of the kingdom, and Prof. Dawkins has even suggested that the *tauri sylvestres* mentioned by Fitzstephen, who wrote his "Life of Beckett" in the reign of Henry II., as inhabiting the forests round London, were aboriginally wild animals. On the other hand, they may equally well have been cattle that had run wild, and this is confirmed by Bishop Leslie, of Ross, who stated in 1598 that the *Bos sylvestris* of the Caledonian Forest was white.

On the Continent, we have the evidence of Cæsar as to the co-existence of the aurochs or urus in the Hercynian, or Black, Forest with the bison and the elk. And it is related how the young German warriors of that time prepared themselves for war by hunting and killing the fierce aurochs. A remarkable confirmation of the truth of Cæsar's statement as to the co-existence of the aurochs and bison on the Continent during the period of the Roman occupation is afforded by the discovery in Swabia, during the widening of a railway in 1895, of two statuettes of oxen belonging to the Roman period. They were dug up in loam at a depth of nine feet below the surface, and have been described and figured by Prof. E. Fraas.* The one, as shown by the great elevation and depth of the forequarters, clearly represents the bison. The other, on the contrary, is as evidently intended for the aurochs. The horns have been broken off in both specimens, but what remains of them agrees in each instance with the form they should assume. In stating that both species inhabited the Black Forest contemporaneously, it is not meant that they were actually found in company. On the contrary, it is more probable, as pointed out by Dr. Nehring, that while the one frequented the low-lying and swampy forests, the other resorted to the higher and drier woods.

Of later chronicles than Cæsar's, one describing the wars of Charlemagne in the early part of the ninth century alludes to the king going to hunt bison or aurochs (*bisontium vel urorum*) in the forests of Aix-la-Chapelle. The use of the term *vel* is a little ambiguous, but Prof. Dawkins considers that the passage indicates the occurrence of both species in the forest, while he is also of opinion that the animal slain by Charlemagne was undoubtedly an aurochs. Of special importance is the mention of both bison and aurochs (urus) in a grace used at the Abbey of St. Gall about the year 1000. Another important statement is to the effect that aurochs and elk were met with by the First Crusade when crossing Germany at the close of the eleventh century, special reference being made to the enormous size of the horns of the former animals. Again, in the "Niebelungen-Lied," of the twelfth century, Tregfried is related to have killed a bison and four aurochs near Worms.

At the time Professor Dawkins wrote the account, to which reference has been already made, nothing more was known concerning the history of aurochs from the evidence of contemporary writers till the time of Gesner (1622). A work by the German writer Herberstain, entitled "Moscovia," of which an Italian translation was published at Venice in 1550, affords, however, the most important evidence of any as to the survival of the aurochs in Poland (and probably also in Hungary) during the latter Middle Ages. In this work appear woodcuts—rude, it is true, but still characteristic and unmistakable—of two perfectly distinct types of European wild cattle; one being the aurochs, or ur, and the other the bison. As Herberstain had travelled frequently in Poland, it is probable that he had seen both species alive, and the drawings were most likely executed under his own immediate supervision and direction. It has been suggested that the figure of the aurochs was taken from a domesticated ox, but Messrs. Nehring and Schiemenz have shown that this is quite a mistaken idea. Not the least important feature of the work of Herberstain is the application of the name aurochs to the wild ox, as distinct from the bison. The locality where aurochs survived in Herberstain's time was the Forest of Jaktozowka, situated about 55 kilometres west-south-west of Warsaw, in the provinces of Bolemow and Sochaczew. From other evidence it appears that the last aurochs was killed in this forest in the year 1627. It is important to notice that Herberstain describes the colour of the aurochs as black, and this is confirmed by another old picture of the animal. Gesner's figure of the aurochs, or as he calls it, "thur," given in his "History of Animals," published in 1622, was probably adapted from Herberstain's. It may be added that an ancient gold goblet depicts the hunting and taming of the wild aurochs.*

As a wild animal, then, the aurochs appears to have ceased to exist in the early part of the seventeenth century; but as a species it is still among us, for there can be no doubt the majority of the domesticated breeds of European cattle are its descendants, all diminished in point of size, and some departing more widely from the original type than others. Aurochs' calves were in all probability captured by the prehistoric inhabitants of Britain and the

* "Fundberichte aus Schwaben," Vol. VII., p. 37 (1899).

* *See* Keller, *Globus*, Vol. LXXII., No. 22 (1897).

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Continent and tamed; and from these, with perhaps an occasional blending of wild blood, are doubtless descended most of our European cattle.

Much misconception has, however, prevailed as to which breeds are the nearest to the ancestral wild stock. For instance, in 1866, Professor Dawkins wrote as follows:—"The half-wild oxen of Chillingham Park in Northumberland, and other places in northern and central Britain, are probably the last surviving representatives of the gigantic urus of the Pleistocene period, reduced in size and modified in every respect by their small range and their contact with men."

When this was penned, it is only fair to state, the fact that the colour of the aurochs was black does not appear to have been known to the writer; neither was it then generally recognized that the park-cattle (which are always white) are semi-albinoes. Such semi-albinism is always the result of domestication, as is mentioned in Bell's "British Quadrupeds," and could not have arisen in the wild state. Moreover, the park-cattle display evidence of their descent from dark-coloured breeds by the retention of red or black ears and brown or black muzzles. In the Chillingham cattle the ears are generally red, although sometimes (probably as the result of crossing) black, and the muzzle brown; while in the breed at Cadzow Park, Lanarkshire, both ears and muzzle are deep black, and there are usually flecks of black on the head and forequarters. It is further significant that, in the Chillingham herd, at any rate, dark-coloured calves, which are weeded out by the keepers, make their appearance from time to time.

Now it is a remarkable fact that when the black Pembroke breed of domesticated cattle tends to albinism, the ears and muzzle, and more rarely the fetlocks, remain completely black or very dark grey, although the colour elsewhere is whitish, more or less profusely flecked and blotched with pale grey. In the shape and curvature of the horns, which at first incline outwards and forwards, and then bend somewhat upwards and inwards, this breed of cattle, which is known to be of great antiquity, resembles both the gigantic aurochs and the (by comparison) dwarfed park breeds. Moreover, in both the Pembroke and the park breeds the horns are light-coloured with black tips.

Important evidence as to the close affinity between these two breeds is furnished by Low in his "Domesticated Animals of the British Islands." It is there stated that a breed of cattle very similar to that at Chillingham was found in Wales in the tenth century; these cattle being white with red ears. "The individuals of this race yet existing in Wales are found chiefly in the county of Pembroke, where they have been kept by some individuals perfectly pure as a part of their regular farm-stock. Until a period comparatively recent, they were relatively numerous, and persons are yet living who remember when they were driven in droves to the pasturages of the Severn and the neighbouring markets. Their whole essential characters are the same as those (of the cattle) at Chillingham and Chartley Park and elsewhere. Their horns are white, tipped with black, and extended and turned upwards in the manner distinctive of the wild breed. The inside of the ears and the muzzle are black, and their feet are black to the fetlock joint. Their skin is unctuous and of a deep-toned yellow colour. Individuals of the race are sometimes born entirely black, and then they are not to be distinguished from the common cattle of the mountains."

It is thus evident that the white park-cattle are a specialized offshoot from the ancient Pembroke black breed, which, as Low mentions in a later passage, from their soft and well-haired skins, are evidently natives of a humid climate, such as that of the forests in which dwelt the wild aurochs. This disposes, once and for all, of a theory recently broached that the park-cattle are descendants of a white sacrificial breed introduced by the Romans.

A further inference is that the Pembroke cattle are themselves the most immediate descendants of the wild aurochs (which, as we have already seen, was black) now living in the British Islands, or perhaps indeed anywhere else. That the park-cattle have in some cases reverted to a semi-wild state, whereas the Pembrokes are thoroughly domesticated, has nothing to do with the argument, and is merely the result of the force of circumstances.

To some persons the red ears of the Chillingham and some of the old Welsh white cattle may give rise to a doubt as to the relationship with the aurochs and Pembroke breed; but it should be borne in mind that red is the primitive coloration of all wild cattle, and that, for ought we know to the contrary, the calves, or even the cows, of the aurochs may have been of this colour, as are those of the banting or wild ox of Java, of which the old bulls are black. The red ears of the Chillingham breed are therefore, at most, a reversion to the colour of the ancestors of the aurochs.

From the foregoing statements it is evident that the aurochs and the Pembroke and park-cattle belong to one and the same species, and since the latter do not appear specifically separable from the domesticated cattle of Scandinavia, which probably formed the type of the *Bos taurus* of Linnæus, it is clear that the aurochs has no right to a distinct species name. Instead of *Bos primigenius*, it should be called *Bos taurus primigenius*.

In conclusion, it may be mentioned that the article on Four-horned Sheep which appeared some time ago in KNOWLEDGE resulted in the presentation to the British Museum of some interesting specimens, and the acquisition of some valuable information with regard to different breeds in which that abnormality occurs. I may now take the opportunity of stating that skulls of the various breeds of domesticated cattle—especially of the Pembroke and park breeds (other than Chillingham)—are much wanted for the National Natural History collection.

## ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

### XIII.—A MODERN TYCHO.

IN the Chapter on the "March of the Planets," I remarked, "This field of work has been so completely occupied in modern times by the transit circle and allied instruments that it is now hopeless for the astronomer without a telescope to dream of obtaining results of any value." Yet though this is the case, it has happened even in our own day that circumstances have precluded an astronomer, not merely from using optical means and modern instruments of precision, but even from availing himself of the results which others have secured by their means. This condition prevails in India where religious sentiment places an embargo upon the results of western science. The very essence of Hindu life is the faithful carrying out of a routine of religious observances, inseparably connected with the knowledge of the positions of the planets and stars. For this purpose a full and correct calendar is needed for the right ordering of every Hindu family. To Europeans astronomy is the pursuit of the very few, and the multitude know nothing and care less about the planetary movements. Such ignorance to the Hindu

would indicate a blameworthy indifference to the duties of religion and to the requirements of society.

But a serious difficulty has been growing for many years. Two hundred years ago Rajah Jey Singh noted that the calculation of the places of the stars as obtained from the tables in common use, gave widely different results from those obtained by observation; the times and magnitudes of the eclipses of the sun and moon, the times of the risings and settings of the planets, and of the appearance of the new moon, were all faulty; the ancient Siddhantas having been left without revision from the time of Bhaskara, the author of the Siddhanta-Siromani, nearly six hundred years before. It was in consequence of this discrepancy, keenly felt even then, that Rajah Jey Singh obtained the permission of Mahommed Shah to erect observatories in order to obtain new data by which the tables should be corrected. Three of the five observatories erected by Jey Singh are well known, those of Jeypore, Delhi, and Benares. Of these, the one at Delhi, established about the year 1710, appears to have been the first.

The Gentur Muntur, or Royal Observatory of Delhi, though barely two centuries old, is of a thoroughly ancient type in its conception, and was intended for naked eye work alone. Just as at the Royal Observatory at Greenwich the transit circle and altazimuth are considered the two fundamental instruments, so here at Delhi the chief structures were evidently designed for corresponding purposes.

The first object to catch the eye is the great gnomon, the vertical section of which is a right-angled triangle, with an hypotenuse of 118 feet, a base of 104 feet, and a perpendicular height of 57 approximately. The face of the gnomon therefore is parallel to the axis of the earth, its angle corresponding to the latitude of Delhi. Up the middle of the gnomon runs a staircase, and right and left of the gnomon are great sectors on which its shadow falls; these also being provided with steps over which the shadow took four minutes of time, corresponding to one degree of arc, to pass. A smaller structure near has some variations in its design, the gnomon being in the centre and flanked on either side by semi-circles sloping downwards from it towards the horizon. Further to the south of these gnomons, the chief use of which must simply have been to give the solar time, are two large buildings, which are evidently intended to serve as altazimuths. The two buildings are exactly alike in design and size, and they give the appearance from outside of being miniatures of the Colosseum at Rome. Within they are seen to be perfectly circular enclosures. The wall of each is pierced by three tiers of windows, thirty in each tier, the breadth of each window opening being precisely equal to the width of the wall between each pair of windows. The difference between the two buildings is simply a question of position, the two being so arranged that the windows of one command precisely those azimuths which are hidden by the wall of the other. In the centre of each enclosure is a pillar rising to the height of the enclosing wall, whilst from the circular wall thirty stone sectors are directed towards the central pillar, but do not quite reach it. The building is 172½ feet in circumference, or 55 feet in diameter, and the sectors running from the wall towards the pillar are 21½ feet in length. The windows, no doubt, were intended to enable the altitude and azimuth of any celestial object to be read off at sight, and for rough positions no doubt it did fairly well. Still Jey Singh does not seem to have effected any reformation of the Indian Calendar, and his observatories, despite their great size, cannot have been of much value for really scientific work.

The interest of Jey Singh's observatories lies for us in the fact that they recall a time far in the past when astronomers sought for exactness by the erection of huge structures of stone. Of these the Great Pyramid is by far the greatest and most perfect example. The north shaft, pointing to Alpha Draconis, the pole star of the period, the grand gallery which may very well, as Proctor suggests, have been used as a vast transit chamber, give evidence of

The Gentur Muntur, or Royal Observatory of Delhi.

its astronomical purpose, whilst the care with which the exterior of the Pyramid has been oriented, would fix most delicately the dates of recurrence of the spring and autumnal equinoxes. This would be seen from the circumstance that on one day in spring the north face of the Pyramid would be in shadow at sunrise, and the next day the south face, whilst the reverse effect would be noted in the autumn. The exact days of the equinoxes would not indeed be thus pointed out, but the return of the year to the same point would be marked with great prevision.

Britain has its own monument—Stonehenge—which has been claimed as, if not indeed an astronomical observatory, at least an astronomical temple, and many attempts have been made to determine the date at which it was erected. The difficulty, not to say the impossibility, of solving this problem in the present state of the monument may be inferred from the fact that the dates which different careful observers have deduced for its erection extend over a period of more than 2000 years.

The real work of astronomy, even in the pre-telescopic age, was never done in edifices like these. Nor, indeed, does it require much knowledge of human nature, essentially the same 5000 years ago as to-day, to see that the true secret of the Pyramid, the amply sufficient cause for its building, was the vanity of the ruling Pharaoh. We get a graphic hint of this in the narrative in Genesis of the founding of a yet earlier observatory, for so no doubt it was. "They said, go to, let us build us a city and a tower, whose top may reach unto heaven, and let us make us a name." Alike at Delhi, at Ghizeh, and on Salisbury Plain, as by the Euphrates, to "make a name" was, beyond doubt, the exciting motive. Astronomers may have been employed to superintend the work, astronomy, or the cult of the celestial bodies, may have been the excuse, but the real object was advertisement.

But the work which the pretentious buildings of the Rajah of Amber failed to accomplish has been done quite recently by very humble means, and by a recluse in an obscure village in the hills of Orissa.* Chandrasekhara Simha Samanta is a near relative of the Raja of

* *See* KNOWLEDGE, Vol. XXII., p. 257. Siddhanta-Darpana.

Khandapara, one of the tributary chiefs of Orissa At the early age of ten, having been taught a little astrology by one of his uncles, he became most anxious to measure on his own account the positions of the stars in their nightly movements, and by the time that he was fifteen years of age and had learned to calculate the ephemerides of the planets and of the risings and settings of stars, he was deeply disappointed to find how great was the discordance between his calculations and what he actually observed. It was no wonder that he found discordances; no two of the current Hindu almanacs agree in their predictions, and one of the most widely circulated of the Bengali almanacs may be as much as 4° out in the longitude of a planet.

In this difficulty Chandrasekhara had to work out his problem unaided. He had to make his instruments for himself, to some extent he had to devise them. The one of which he was fondest is a tangent staff consisting of a thin rod of wood twenty-four digits long, at the end of which is fixed another rod at right angles in the form of T. The cross piece is notched and also pierced with holes equal to the tangents of the angles formed at the free extremity of the other rod.

For many years he has been carefully revising the Siddhantas in order to bring them into conformity with his observations made at the present period, and he has been able to obtain a most astonishing degree of accuracy in his results. Thus, the sidereal period for Mercury is only 0·0007 days different from that adopted by European astronomers; for Venus it is only 0·0028 days. The mean inclinations of the orbits of the planets to the ecliptic are correct to about a minute of arc. The errors of the ephemerides computed from his new constants are reduced to about one-tenth of those in some of the most widely circulated Hindu almanacs. In his discussion of the moon's motion, he made the discovery—independent and original on his part—of the lunar evection, variation and annual equation, which found no place in the earlier Siddhantas. In much of his work he had the advantage of comparing his observations with those of Bhaskara, made more than seven hundred years earlier; not indeed that the latter had recorded his actual observations, but it was possible to ascertain what they must have been from the planetary elements which he had deduced from them. Nevertheless, to have obtained such important results and so high a degree of accuracy, by naked-eye observations and with entirely home-made instruments, and in the utter absence of modern book learning, is a striking illustration of what resolution can effect.

Chandrasekhara has been compared to Tycho Brahe, and the comparison is in many ways a just one, though the recluse of Orissa lacked many of the advantages possessed by the noble Dane. As to the accuracy of Tycho's work, it will be remembered that Kepler was led to the first of his three great laws by finding that his theory of the circular motion of the planets was irreconcileable with an observation of Mars by Tycho by eight minutes of arc—but one-fourth of the moon's diameter—Kepler concluding that it was impossible that so good an observer could be in error to this extent, abandoned his hypothesis and tried that of motion in an ellipse.

In the recluse of the Orissa village, we seem to see reincarnated, as it were, one of the early fathers of the science, long centuries ere the telescope was dreamed of, as he grappled with the problems which the planetary movements offered to him for solution. More than that, he affords an example of the achievements within the reach of the naked-eye astronomers, and a telling illustration of the precision which patience and practice can give to hand and eye. And these are always needed. For be the telescope ever so good and powerful, still that which is by far the most important is the man at the eye-end.

## CLOUDS.

By Commander D. Wilson Barker, R.N.R., F.R.S.E., F.R.Met.Soc., etc.

Those who are professionally engaged in the scientific work of weather bureaux recognise the importance of accurate observations of cloud forms and nature, and much good work has been done in this connection in recent years by scientific observers in England, Australia, and the United States; but, as a popular study, Nephology is almost entirely overlooked, and this notwithstanding the fact that, perhaps, no branch of knowledge offers greater facility and ease of acquisition. Each cloud has its history fraught with meaning; its open secret is writ on its face, and may be read by anyone who will give himself a little trouble, nor need he go deeply into the study in order to make observations interesting to himself, and perhaps of great use in the furthering and perfecting of weather lore. To the ancients, the sky was doubtless an object of constant remark and interest, and possibly their intuitive knowledge of weather forecasting was much more accurate than ours. The dwellers in our modern cities see little of the sky, clouds have no interest for them beyond the personal consideration as to the advisability of taking out an umbrella or not. But farmers, fishermen, sailors and others following open-air avocations are dependent on the weather, and to be wise in its forecast is of importance to them. To these, especially, cloud study should appeal; it cannot fail to be profitable to them in their personal work, and they have all the opportunity, if the will be there, to forward the general knowledge of the subject by careful painstaking observations, which they may transmit to those scientifically engaged in dealing with weather

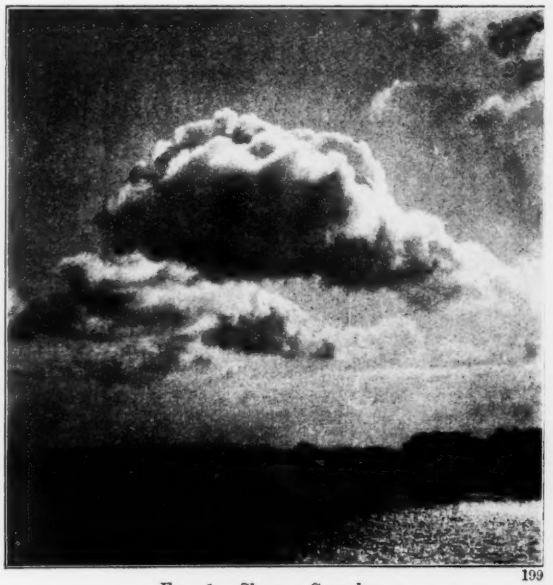

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Fig. 1.—Shower Cumulus.

laws, and thus assist in the elucidation of questions on which we are at present but very imperfectly informed.

In this article the broad distinctions of clouds will be dealt with. There are two well-defined types—Stratus

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Plate I.—SQUALL CUMULUS. A Tornado, Sierra Leone, W.C.A. 1

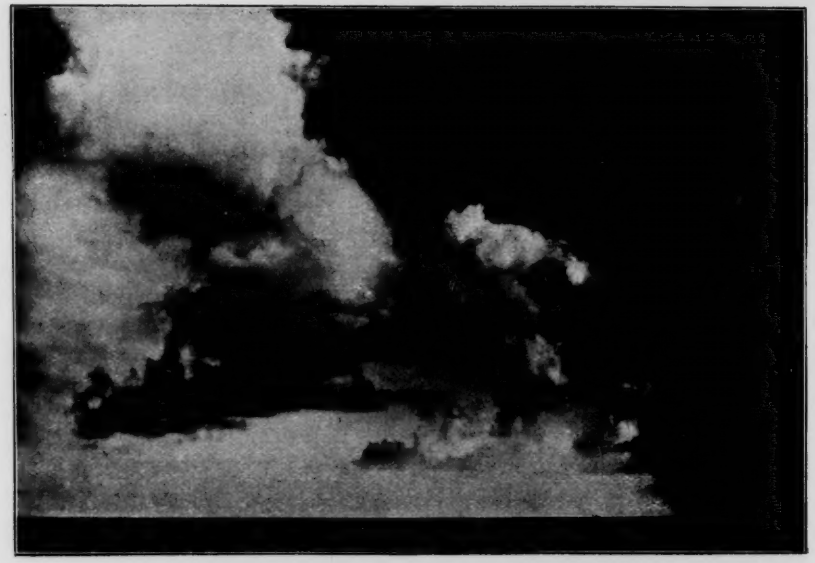

Plate II.—PILLAR CUMULUS. 25

Plate III.—CIRRUS. 179

Plate IV.—HIGH STRATUS AND CUMULUS. 6

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and Cumulus—so distinct in actual appearance and in physical formation that they may be taken as the basis of classification. Sometimes both types appear to merge into each other, in which case no variety of classification suffices to describe them satisfactorily, as anyone who has studied cloud-forms must allow. "Stratus" is a sheet-like formation of cloud. "Cumulus" is recognizable by its heaped-up appearance and vertical thickness. Numerous

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FIG. 2.—Squall Cumulus.

varieties of cloud-forms may be observed graduating from one of these types to the other, but when an observer can clearly distinguish Stratus from Cumulus he has already acquired valuable knowledge.

The presence of either type of cloud alone indicates a more or less set condition of the atmosphere, and generally foretells a continuance of the existing weather. The simultaneous presence of both types indicates a coming change, the gradation of Stratus into Cumulus foreboding worse weather, and of Cumulus into Stratus heralding good. Again, as we shall show later on, the vertical thickening of the stratiform clouds is a distinctly bad indication.

Up to quite recently, Luke Howard's division of clouds, formulated in 1802, held first place; even now it is in constant use, for though attempts have been made at a more scientific classification, all of them, with the single exception of that proposed by the late Rev. Clement Ley, can only be termed make-shifts. Mr. Ley's classification unfortunately is long, and not well adapted to the use of any but professional investigators, or enthusiasts with ample time on their hands. There exists a so-called "international" system of cloud nomenclature, but, for all that, each country has its own especial system, with the result that vast collections of cloud statistics are of little value as helps to a classification, and are useful only as records of clouds present at certain times.

Clouds owe their existence to two causes:

1. Through the passing of warm moist air into colder, when, owing to condensation, a certain proportion of the moisture becomes visible in the form of a cloud.

2. Through changes occurring in the atmosphere as it rises into higher regions of atmosphere, where decrease in pressure and expansion and consequent loss of heat take place and cause condensation of moisture.

The first process may be described as the condensation formation of clouds, and the second as the adiabatic formation of clouds. As a matter of fact, no hard and fast line separates these two operations; they act in unison, and the combination of vertical and horizontal currents go to make up the diversity of forms which clouds assume.

In settled states of the atmosphere, Stratus clouds are common, or the sky may be perfectly clear. In unsettled conditions, Cumulus or Heap clouds are formed.

We shall now describe a few familiar forms of cloud,

FIG. 3.—Cumulus. 251 (a)

giving them simple names and endeavouring to compare them with other nomenclatures.

Of Cumulus clouds there are five well-defined varieties as follows:—

(1) Fine weather variety ... ... Cumulus
Clement Ley ... ... ... ,,

| | | |
|---|---|---|
| International Cloud Atlas | ... | Cumulus |
| Meteorological Office Book | ... | ,, |
| U. S. Hydrographic Atlas | ... | ,, |

(2) *Rain Cumulus*, of which there are two sub-varieties:—

(*a*) Shower-cumulus (Fig. 1), when rain falls from the cloud without increment of wind. The edges of this cloud are not cirrus-topped.

(*b*) Squall-cumulus, when the rain is accompanied by wind (Fig. 2 and Plate I.), or by wind with hail and snow falling from this cloud.

| | | |
|---|---|---|
| Clement Ley | ... | Cumulo-Nimbus |
| I. C. A. ... | ... | ,, |
| M. O. B. ... | ... | ,, |
| U. S. H. O. A. ... | | ,, |

In these cases the Cumulus cloud is generally much serrated, having a cirriform edging. In some cases this cirriform edging extends far over the sky and forms halos, particularly at the rear.

Two rarer varieties of Cumulus are:—

*Pillar-cumulus* (Plate II.) generally noticed over the calm belts of the ocean, and distinguishable by its slender forms, which rise to great altitudes.

251 (*b*)

FIG. 4.—Cumulus.

*Roll-cumulus* generally accompanies strong winds, particularly polar west winds, which succeed cyclonic disturbances. Here we have the ordinary Cumulus cloud so blown along by the wind as to assume the roll formation from which it is named.

| | | |
|---|---|---|
| Clement Ley | ... | ... |
| I. C. A. | ... | ... |
| M. O. B. | ... | ... Roll-cumulus |
| U. S. H. O. A. | ... | ... Strato-cumulus |

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FIG. 5.—Fog.

A still rarer form of Cumulus appears in scattered patches over the sky, and is indicative of an electrical state of the atmosphere.

Cumulus clouds form at a low altitude, but they frequently tower upwards to great heights.

It should be noticed that in these clouds the fine weather form is of soft smooth outline, and has a quiet appearance. In Fig. 1 (a form which indicates rain) there is a harder and more solid appearance, which is still more accentuated in the Squall-cumulus form of cloud.

Figs. 3 and 4 show respectively a horizontal and vertical view of a Cumulus which, later in the day, developed showers.

*Stratus Clouds* may be divided into four varieties as follows:—

(1) *Fog* (Fig. 5), so well known as not to need description. It is, in fact, a Stratus cloud resting on the earth's surface.

| | | | | |
|---|---|---|---|---|
| Clement Ley | ... | ... | ... | Nebula |
| I. C. A. | ... | ... | ... | ... |
| M. O. B. | ... | ... | ... | Fog |
| U. S. H. O. A. | ... | ... | ... | ,, |

(2.) *Stratus* (Fig. 6), a cloud sheet which covers the whole sky at a moderate elevation. Here and there the cloud is thin, and under surfaces appear as parallel lines all round the horizon. This is the characteristic cloud of anti-cyclonic, or dry fine weather conditions. It may continue to cover the sky for several days in succession.

| | | | |
|---|---|---|---|
| Clement Ley | ... | ... | Stratus Quietus |
| I. C. A. | ... | ... | Strato-cumulus |
| M. O. B. | ... | ... | Stratus |
| U. S. H. O. A. | ... | ... | Stratus |

(3) *High Stratus*, including all the varying forms of Cirro-cumulus from the mackerel skies (Fig. 7) to the Cirro-macula (Fig. 8) of Clement Ley. Many beautiful varieties of this cloud of minute cumuliform appearance are caused by the changes taking place in the atmosphere. We notice waves, wavelets, stipplings, and flecks. To it are due the coronæ sometimes seen round the sun, as also iridescent clouds occasionally noticed in the same vicinity. The wave-like appearance of the clouds is due to the

passage of a more rapidly-moving air current over a slower one, or of a wave current crossing a motionless portion of the air. When two air currents pass over one another at an angle, the particles of clouds tend to fall into different shapes, hence our mackerel skies. But this cloud (Fig. 7 and Fig. 9), although beautiful, is essentially one of warning,* more especially when the flecks are of a thin, scaly appearance (resembling the scales of certain fishes so closely that I have called it the scale cloud). Sometimes these detached flecks appear in lines, and very striking is the effect produced.

Fig. 7 and Fig. 9.—C. L. .. ... Stratus Maculosus.
" I. C. A. ... Alto-cumulus.
" M. O. B. ... Cirro-cumulus.
" U. S. H. O. A. Alto-cumulus.
Fig. 8.—C. L. ... .. Cirro-macula.
" I. C. A. .. Cirro-cumulus.
" M. O. B. .. "
" U. S. H. O. A. "

43

FIG. 6.—Stratus.

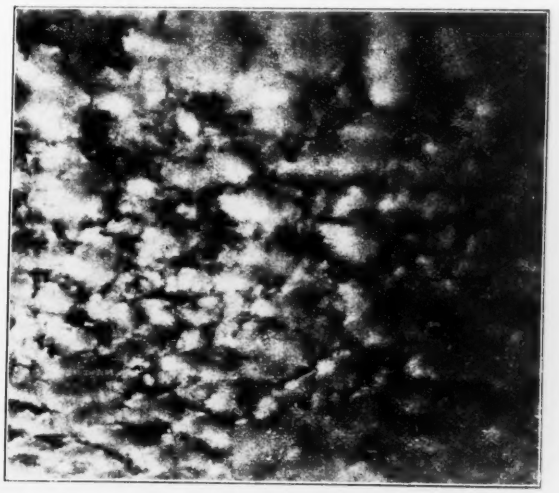
(4) *Cirrus.*—The highest form of cloud and the most important as a factor in the science of weather forecasting. Cirrus, ordinarily, appears as wisps and feather pieces scattered over the sky, and its significance is then of no import (Fig. 10).

Fig. 10—Clement Ley ... ... ... Cirrus.
" I. C. A. ... ... .. "
" M. O. B. ... ... ... "
" U. S. H. O. A. ... ... "

When, however, this cloud takes the form of lines parallel to the horizon, or of lines appearing to radiate as wheel-spokes (Plate III.) from any one part of the horizon, it should be carefully noted as indicative of approaching weather. Its movement and propagating transition should be observed. This cloud is composed of ice-dust or crystals.

Plate III.—Clement Ley ... Cirro-filum.
Fig. 11.—Clement Ley ... Cirro-velum.
" I. C. A. ... ...
" M. O. B. ... ... Cirro-stratus.
" U. S. H. O. A. ... "

When a cyclonic disturbance is about to pass over an observer, Cirrus generally appears first in parallel lines, or at a radiant (V) point (Plate III.); the threads gradually increase and interlace until a complete sheet of Cirro-stratus covers the sky, causing a halo (Fig. 11). The cloud further thickens, the halo disappears, all becomes overcast, and rain comes on. The cloud is now known as Nimbus, and after it has endured some time, the wind



205 (a)

FIG. 7.—Mackerel Sky.

shifts, the Nimbus clears off, and it is succeeded by a Polar west wind, and the form of cloud shown in Fig. 2.

In addition to these forms of clouds, we may often

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FIG. 8.—High Stratus, Mackerel Sky.

notice, particularly during high winds, fragments of clouds hurrying across the sky. These are known as "scud";

* Fig. 9 preceded a heavy gale by about twelve hours.

they are generally pieces carried off by the winds from the main bodies of clouds.

Occasionally two forms of cloud are present at the same time. This is ordinarily taken as a case of Cumulus and Stratus, and has become known as Cumulo-stratus; but, if observed in the zenith, it may readily be noted that the two forms of cloud are distinct, and they had better be dealt with separately. The appearance of Cumulo-stratus is an effect of perspective. (Fig. 12 and Plate IV.)

Clouds float at varying altitudes, according to the latitude and elevation of the ground; the vertical temperature and adiabatic gradients determining the level at which the vapour becomes visible as cloud. It is desirable in all cloud observations, that note should be made of the approximate relative altitudes of clouds and of their velocity of motion. This is particularly desirable when dealing with the stratiform clouds, whether as ordinary Cirro-cumulus or as very high Cirro-macula.

The rate at which they move may be noted from the following table:—

0.—No perceptible motion.
1.—Just moving.
2.—Moving at moderate speed.
3.—Moving quickly.

The beautiful colouring of clouds results from the breaking up of light beams in passing through them or along their edges. This phenomenon is caused by diffraction, and to it is due our lovely sunrises and sunsets. When the sun is high in the heavens, the light is white, but as the orb nears the horizon, and its rays pass through

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FIG. 9.—High Stratus, Mackerel Sky.

thicker layers of atmosphere, the smaller light waves get gradually cut off, until the sun sinks as a red ball below the horizon. The largest waves of light produce the red rays and the after glow which are so beautiful. Sunrise and sunset effects are matters of much interest, but are of too complicated a nature to be fully gone into here; we must, however, notice them briefly, because of their importance in weather forecasts. Soft sunset colours indicate fine settled weather; fiery brilliant hues denote change to stormy or wet weather.

Other colour effects in clouds are due to phenomena, known as halos and coronæ. Halos appear as rings round the sun and moon; they are caused by the shining of the orb through very high Stratus or Cirrus clouds, and have a diameter of 42° (Fig. 11). Sometimes shades of colour,

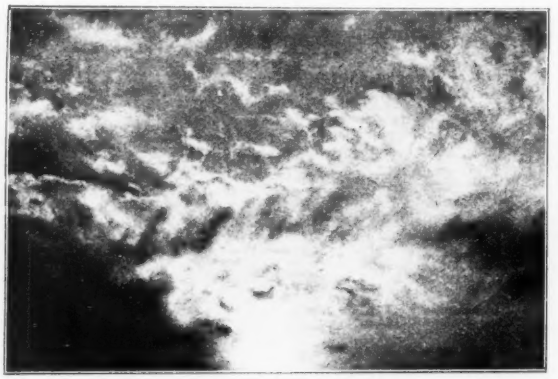

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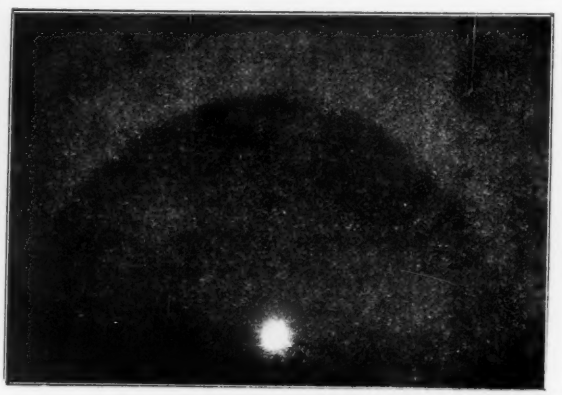
FIG. 10.—Cirrus.

resembling those of a rainbow, are visible—red appears on the inside and blue on the outside. These rings of colour are due to the reflection and refraction of light passing through the fine ice crystals of which high Stratus or Cirrus clouds are composed. Occasionally a complicated series of beautifully coloured rings is noticeable, producing the effect represented in the accompanying picture (Fig. 13). Generally speaking, these rings are due to the thinness of the high cloud through which the light is passing. Still more curious arrangements of halos sometimes occur.

Coronæ are broader rings seen quite close to the sun or moon, and are due to the shining of light through the edges of loose Cumulus or Stratus clouds. They have red on the outside and blue on the inside of the ring; the colours are, generally, easily distinguishable. The more brilliant hues occasionally seen, as has been said, in the vicinity of the sun and moon, would appear to be incomplete sections of circles intermediate in size between



222 (b)

FIG. 11.—Halo.

coronæ and halos. An interested observer will be well repaid if he chooses to study more closely the many curious optical phenomena connected with clouds, but it

would be beyond the scope and object of this notice to go into them more fully here.

Whoever wishes to be weather wise, and who has time to study the weather charts published daily, may easily acquire such knowledge of local characteristics as will enable him to forecast fairly accurately. Cirrus clouds, as a rule—at any rate in England—are reliable guides; they form, as we have said, in parallel threads, from the

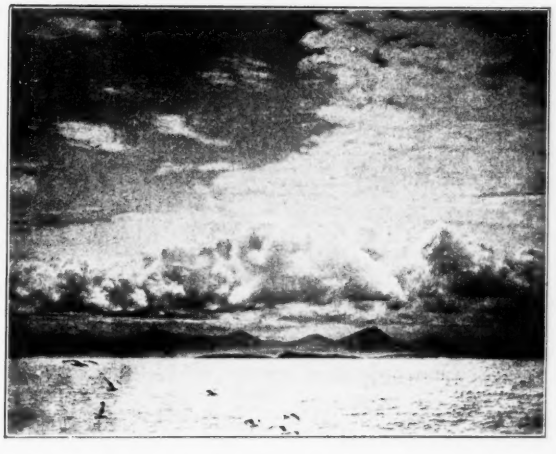


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FIG. 12.—High Stratus and Cumulus.

position and movements of which forecasts may be made. Should the threads appear on, and parallel to, the west horizon, and moving from a northerly point, a depression is approaching from the west, but, although causing some bad weather, it will probably pass to the north of the observer. Should the lines appear parallel to the south-west or south-south-west horizon, and be moving from a north-westerly point, the depression will very likely pass

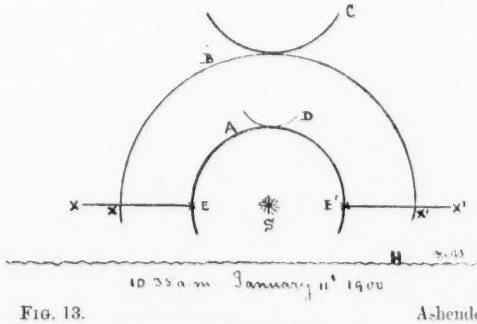



FIG. 13. Ashenden, Sussex.

EXPLANATION.

S.—Sun shining through Cirrus haze.
H.—Horizon.
A.—Inner and bright halo, showing colours, red inside.
B.—Faint large halo, white.
C.—Brilliant portion of halo, showing colours distinctly, red outside.
D.—Small halo, showing faint colours.
E, E¹.—Mock Suns.
E X, E¹ X¹.—Rays from mock suns, white, brighter from East one than from W. one.
It lasted like this for about half-an-hour.

over the observer and occasion very bad weather. These are two of many possible prognostics. Weather forecasting is much helped by a study of the daily weather charts. Again, weather is often very local, and to predict with fair accuracy a knowledge of local conditions is necessary.

It is hoped that enough has been said in this article to attract more than a passing attention to clouds. If an observer be a photographer as well, he will find open to him in Cloudland a fascinating field for study and a limitless variety of subject for his art.

## Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

### FAHRENHEIT'S THERMOMETER.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I note on page 29 of your journal for February an article on the history of Fahrenheit's thermometer. Those desiring fuller information can find it, either in the elaborate article by Renou, in the *Annuaire* of the Meteorological Society of France, or in the first chapter of my Treatise on Meteorological Apparatus and Methods, Washington, 1887. There is every evidence that the Fahrenheit scale began with his use of plus 90 as the upper limit of the temperature of the human body, and minus 90 for the lowest temperature of the air in Europe, and also the temperature obtained by the mixture of salt and ice. Subsequently, he also used a second scale in which plus 12 and minus 12 replaced the plus 90 and minus 90. In 1714, he adopted a third scale, viz., plus 24 for the temperature of the body and zero for the lowest temperature at Dantzic in 1709. His fourth scale was plus 96 for the temperature of the human body and zero for the great cold of 1709. This scale gave him 32 as the temperature of melting ice, but that natural point was not directly adopted by him. With this first satisfactory mercurial thermometer (made in 1721, and whose scale was graduated according to this last system but extended much further upward, by extrapolation) he found that the boiling point of water was constant, or nearly so, at 212 deg. The fact that Newton's "arithmetic scale" read 33 or 34 for boiling water, had no influence with Fahrenheit in the formation of his scale. The arbitrary points assumed by Newton were 12 for the temperature of the human body and zero for the temperature of freezing water. I do not find that he measured the temperature of boiling water, and I am very sure that the account of the evolution of the Fahrenheit thermometer, as given by your correspondent, needs to be corrected in several particulars. I am not aware of any evidence that Fahrenheit obtained any of his ideas from Newton's work, and I am sure that those interested in the history of philosophical apparatus will be glad to obtain additional light on the subject.

CLEVELAND ABBE.

U. S. Department of Agriculture,
Weather Bureau, Washington, D.C.,
March 26th, 1902.

### THE VISIBILITY OF THE CRESCENT OF VENUS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the last number of KNOWLEDGE Mr. Maunder raises the question as to the visibility of the crescent of Venus with the naked eye, as well as of the satellites of Jupiter under similar circumstances.

My own eyesight is not nearly good enough for either one or the other, but I find that the late Mr. Webb, in his "Celestial Objects," p. 53, states that Theodore Parker saw the crescent with the naked eye in America, and that, *seemingly*, another observer saw it in Chile. He also gives

several instances on p. 175 of the visibility of Jupiter's satellites with the naked eye.

I should like to know if Mr. Maunder concurs with Mr. Webb or not.

I can just make out Venus' crescent myself with a binocular of Browning's; diameter of object glass, $1\frac{2}{5}$ inch, focal length, 8 to 9 inches.

Apropos of Mr. C. Jackson's note on p. 81, I recollect that in July, 1873, being then at St. Leonards on a visit, and having, of course, a good horizon, I just managed to see the dark spaces between the rings and body of Saturn, with a small pocket glass by Ross; object glass $1\frac{1}{5}$ to $1\frac{1}{2}$ inches, and power of about 29, a very similar glass to that referred to on p. 2, Vol. I. of Webb.

Pawston, Cornhill-on-Tweed, B. P. Selby.
April 15th, 1902.

[I fear that I cannot add anything to what I have already written as to the crescent of Venus being visible to the naked eye, viz., that I think it "outside the limit of possibility." If it has ever been achieved, then certainly the observer must have been possessed of most exceptional powers of sight. The case of Theodore Parker, quoted by the Rev. T. W. Webb, *may* be a real one, as children sometimes show an acuteness of vision which is not retained in mature life: but I should personally feel no confidence in any statement of the kind that I had not been able to subject to a rigorous testing. I have repeatedly tried to make the observation myself at a time when my eyesight was distinctly above the average in quality. Thus I could at one time count eleven stars in the Pleiades, I have distinctly identified both Uranus and Vesta when in opposition and high in declination, I could clearly separate $\varepsilon_1$ and $\varepsilon_2$ Lyræ, and I have very often seen Venus at mid-day. But I never could make the slightest approach to defining the crescent of Venus, and the optical assistance necessary to do it has always been considerable. The increase of power which is given by such a binocular as Mr. Selby used is very marked indeed, and I am sceptical as to anyone possessing sight in advance of his fellows to an extent comparable with it. I may have done the American Stoddart an injustice, but I always regarded his claim to have seen the crescent of Venus and to have elongated Saturn with the naked eye as "requiring confirmation."

The case of the satellites of Jupiter is quite different. I see no reason why III. should not be seen at elongation when the planet is high; nor IV. either, though its comparative faintness will render it a severer test of good sight. Under very exceptional circumstances, II. may be elongated almost four minutes of arc and might then be detected under favourable conditions of weather and altitude of the planet. But I should like to receive very full confirmation of any alleged observation of I. There is no reason to call in question observations where two of the satellites have been close together and have been seen as one, if the distance from their primary was considerable at the time.

I shall feel much gratified if my paper induces many observers to seriously take up the question of these observations, which are so nearly on the limit of visibility, and which form such searching tests of goodness of sight.—E. Walter Maunder.]

TO THE EDITORS OF KNOWLEDGE.

Sirs,—During the recent easterly elongation of Venus, I was one evening watching the planet through Mr. Fowler's "Telescopic Astronomy" telescope. A friend, ignorant of astronomy, and *of the fact that astronomical telescopes give inverted images*, called, and was shown Venus through the instrument. To find out if he really was seeing what he was supposed to see, I asked him the shape of the planet—did it seem round? He answered: "No, it is crescent-shaped as it was last night, but *the crescent is turned the other way*." He had, it turned out, been watching Venus the night before with the naked eye.

The incident convinced me that Venus can be seen as a crescent by the naked eye of at least one man, and is, perhaps, worth repeating in view of Mr. Maunder's remarks on page 79 of the April number.

Schoolhouse, James Rodger.
Rattray, Blairgowrie,
3rd April, 1902.

## British Ornithological Notes.

*Conducted by* W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U.

Spoonbills in Norfolk.—Mr. J. H. Gurney, in the *Zoologist* for March, gives an exceedingly interesting account of a small flock of Spoonbills which frequented Breydon Water, Great Yarmouth, from early April to the end of July, 1901. Thanks to the efforts of the Breydon Wild Birds Protection Society, none of these appear to have fallen victims to the crowd of gunners who haunted the spot in the hope of securing specimens. It is to be hoped that, in the near future, these birds may be induced once again to nest in their old haunts—the heronry of Reedham, close by. Unless, however, the society receives more liberal support from those interested in the restoration of this and other some-time resident species, the society, we note with regret, will be unable to continue its good work; in which case all hope of restoring the Spoonbill to its ancient stronghold must be abandoned.

We have to record, with regret, that a nearly adult female Spoonbill was purchased at Harrod's Stores, London, during Holy Week of the present year (1902), by one of the taxidermists of the Natural History Museum, Cromwell Road. The bird was in good condition, and perfectly fresh. Careful inquiries show that the bird came from Leadenhall Market, and was said to have come up with a consignment of birds from Great Yarmouth.

Pollination by Birds.—An extremely interesting exhibition of photographs was given at the meeting of the Linnean Society on March 6th, illustrating certain New Zealand plants which depend for fertilization upon certain species of birds. The New Zealand bell-bird *(Anthornis melanura)* is one of these fertilizers; performing this office for the native fuchsias and the native flax. In the course of its visitations the bird's head becomes thickly covered with pollen, so that, at different times of the year, according which of these two plants is in flower, the bell-bird may be obtained either with a bright blue or a red forehead; these colours being due to the pollen. Some years ago this led to a curious mistake, Von Pelzen describing one of the red-headed birds as a new species—*Anthornis ruficeps*. Athough at the time many doubted the validity of this, it was not till 1870 that the supposed new species was abandoned, proof having been given of the artificial nature of the red coloration.

Birds and the Production of Pearls.—At the meeting of the Zoological Society held on March 4th, Dr. Lyster Jameson read a paper on the "Origin of Pearls in the Common Mussel (*Mytilus edulis*)." He showed that the pearls commonly found in these molluscs were due to the presence of a parasitic Distomid larva, which, penetrating the mantle of the mussel, became encysted. On the

death of the parasite within the sac, the remains became calcified, and around this nucleus the pearl was formed by the secretion of the epithelium lining the sac. The interest of this paper, to ornithologists, lay in the fact that the adult stage of the parasite was passed in the intestine of the Eider Duck or the Common Scoter, both of which feed largely on mussels.

*Longevity of the Eagle Owl.*—Mr. J. H. Gurney, in the *Zoologist* for March, records the death of one of his Eagle Owls on February 1st. It was believed to be between thirty and forty years of age. In the same communication he points out the fact that Mr. Meade Waldo has in his possession two birds of this species, one—a male—which is seventy-one, and one—a female—which is fifty-six years of age, and the parent of ninety young ones.

*Early Arrival of the Swallow and Sand-Martin.*—The *Field*, March 29th, records the arrival of the Swallow at Exeter on March 20th, and of the Sand-Martin simultaneously at Bath and Exeter on the same date (March 20th); and remarks that this is at least a week earlier than usual.

*All contributions to the column, either in the way of notes or photographs, should be forwarded to* W. P. PYCRAFT, *at the Natural History Museum, Cromwell Road, London, S.W.*

ASTRONOMICAL.—Dr. See has recently made an extensive series of measurements of planets and satellites with the aid of the great Washington refractor of 26 inches aperture, giving special attention to the effects of irradiation in increasing their apparent sizes. The following are among the results obtained:—

| | As observed at night. | As corrected for irradiation. |
|---|---|---|
| Jupiter— | | |
| Equatorial diameter ... | 38″·401 | ... 37″·646 = 141,950 km. |
| Polar diameter ... ... | 35·921 | ... 35·222 = 132,810 „ |
| Oblateness ... ... | | 1 : 15·53 |
| Assumed mass ... ... | | 1 : 1047·35 (Newcomb) |
| Density ... ... ... | | 1·35 (water = 1) |
| Saturn— | | |
| External diameter of outer ring ... ... | 40·274 | ... 39″·971 = 276,474 km. |
| Internal diameter of outer ring ... ... ... | 34·757 | ... 34·605 = 239,358 „ |
| Width of Cassini's division | 0·418 | ... 0·818 = 5,658 „ |
| External diameter of central ring ... ... | 33·921 | ... 33·671 = 232,898 „ |
| Internal diameter of central ring ... ... | 25·932 | ... 25·932 = 179,368 „ |
| Width of central ring ... | 3·995 | ... 3·715 = 25,904 „ |
| Internal diameter of dusky ring ... ... | 20·434 | ... 20·434 = 141,339 „ |
| Width of dusky ring ... | 2·749 | ... 2·749 = 19,014 „ |
| Equatorial diameter of Saturn .. ... ... | 17·804 | ... 17·240 = 119,247 „ |
| Assumed oblateness (H. Struve) ... ... | 0·1013 | |
| Resulting polar diameter | 16·005 | ... 15·494 = 107,167 „ |
| Assumed mass of Saturn (H. Struve) ... ... | 1 : 3495·3 | |
| Resulting mean density of planet ... ... | | 0·7105 (water = 1) |
| Uranus— | | |
| Diameter... ... ... | | 3″·075 = 42,772 km. |
| Mean density ... ... | | 2·09 |

The effects of irradiation were eliminated by making observations about the time of sunset, and using a colour screen consisting of a solution of picric acid and chloride of copper in water.—A. F.

BOTANICAL.—*Torreya* for February contains a paper by Mr. B. D. Halsted "On the Behaviour of Mutilated Seedlings." The mutilation consisted of the removal of the plumule. Seedlings of various plants were experimented on, including some of the garden radish. On removing the plumule soon after the plants were above the ground, it was observed first that the cotyledons assumed a much deeper green than usual; then the petioles developed extraordinarily, becoming three inches long, while the cotyledons attained a breadth of an inch and a half and nearly double the thickness of those of a normal plant. It was also observed that they were raised at an angle of about 45° instead of being approximately horizontal. A microscopic examination showed that the greater thickness of the cotyledons was due to the increased size of the cells, and not to a multiplication of the layers. The roots developed to nearly the ordinary market size. In seedlings of the common sunflower (*Helianthus annuus*), treated in the same manner, a remarkable elongation of the hypocotyl was noticed, this becoming twice as long as in the unmutilated plants.

Among the five plants figured in *Curtis's Botanical Magazine* for March is the first species of the numerous Michaelmas Daisies introduced from North America into European gardens. This is *Aster Tradescanti*. It is a native of the eastern United States, and was first cultivated in this country by John Tradescant, gardener to Charles I., in the royal garden at Lambeth. Tradescant's son travelled in Virginia, and to him is attributed its introduction into Europe. Though this took place about 270 years ago, the present figure is the first to appear, excepting a very rude cut in Morison's "Historia." *A. Tradescanti* has rather small white flower-heads, and is far surpassed in beauty by many more recently introduced species. Other plants figured in the *Magazine* are a handsome new Passion Flower (*Passiflora ambigua*) from Nicaragua, and a very fine Balsam (*Impatiens grandiflora*) from Madagascar. The latter is remarkable for having the largest flowers of all the numerous species of the genus, so far as it is at present known.

At the meeting of the Linnean Society on March 20th, Dr. O. Stapf exhibited some fruits of *Melocanna bambusoides*, a member of the grass family. It will be remembered that the fruits of grasses are nearly always very small, the largest commonly met with being those of the wheat and maize. But in *Melocanna* the pear-shaped fruit attains a length of more than four inches. *Melocanna*, moreover, deviates from the typical grasses in having exalbuminous seeds, a peculiarity present in only three species, so far as has been ascertained, in an order including about 3500. *Melocanna bambusoides* is a native of India, from Assam to Tenasserim.—S. A. S.

ZOOLOGICAL.—According to the preliminary abstract, a paper of much interest and importance, dealing with the evolution of horns and antlers, was read by Dr. Gadow, of Cambridge, before the Zoological Society on March 13th. The author is of opinion that the antlers of the deer, the horn-like protuberances on the skull of the giraffe, and the true horns of the prongbuck and other hollow-horned ruminants (*Bovidæ*) are all different stages of evolution from a single common type: the antlers of the deer being the most primitive, and the horns of the *Bovidæ* the most specialised. From the fact that the bony horn-core of the hollow-horned ruminants develops as a separate ossification, as do the horns of the giraffe, while the pedicles of the antlers of the deer grow direct from the frontal bone,

XUM

it has been proposed by Dr. Nitshe to place the hollow-horned ruminants (inclusive of the prongbuck) and the giraffes in one group, and the deer in another. This arrangement has the disadvantage of separating the deer from the giraffes, to which they are evidently nearly related; and Dr. Gadow has therefore done good work in bringing them more into line. Whether, however, he is right in regarding the hollow-horned ruminants as derived from the primitive deer may, however, be a matter of opinion. One very important fact—apparently unknown to naturalists, whatever may be the case with breeders—recorded by Dr. Gadow, is that calves and lambs shed their horns at an early age. The *Bovidæ* are thus brought into nearer relationship with the American prongbuck (the only living ruminant which sheds its horn-sheath in the adult condition) than has hitherto been supposed to be the case. It is a pity that the editor of the abstract of the paper did not amend such a very German term as "horn-shoe" into "horn-sheath"; and he might also have pointed out to the author that *Uintatherium*, and not *Dinoceras*, is the proper title for an American group of horned ungulates.

An exceedingly interesting and suggestive paper by Captain Barrett-Hamilton written while on active service in South Africa, appears in the February number of the *Annals and Magazine of Natural History*. It describes certain investigations into the life-history of the salmon, and their bearing on nuptial and sexual ornamentation in the animal kingdom generally. Briefly stated, the author's views appear to be that at the breeding season both sexes of the salmon develop in their tissues a large quantity of proteids and fats. By the female these are used up in the formation of the ova. The male, however, has no need of such a large amount of these substances, and consequently they are worked up in the development of colour, abnormal growth of the lower jaw, etc. On the same principle the author accounts for the development of a gorgeous nuptial (or permanent) plumage in the males of many birds, and the development of brilliant patches of colour in certain male apes like the mandrill. The theory also serves to explain the assumption of male characters by old or barren females of many birds. Whether or no we accept the author's views, wholly or in part, the paper contains much valuable information with regard to the life-history of the salmon.

The fact that the lancelet (*Branchiostoma*) has kidneys apparently indistinguishable in structure from the so-called nephridea of the polychætous worms has been recently demonstrated by Mr. Goodrich, of Oxford, the results of whose investigations are recorded in the March number of the *Quarterly Journal of Microscopical Science*. If, as is probably the case, the two organs are homologous, the discovery has an important bearing on the phylogeny of the vertebrata.

According to a paper communicated by Miss Donald to the Geological Society, the Palæozoic univalve shells commonly described as *Murchisonia* belong to two distinct types, the one having a slit and the other a sinus in the lip. Whether those with a slit are in any wise related to the shorter-spired and still living genus *Pleurotomaria*, the author was unable to decide.

The April number of the *Proceedings* of the Zoological Society contains an announcement that a pair of giraffes have been promised to the menagerie by Colonel Mahon, Governor of Kordofan. It is hoped that they may arrive in London during the spring. The same number also contains Mr. Thomas's description of the "five-horned" giraffe skins and skulls sent home from Mt. Elgon by Sir Harry Johnston.

## Notices of Books.

"BRITISH TYROGLYPHIDÆ." By Albert D. Michael, F.L.S., F.Z.S., F.R.M.S., etc. Volume I. (London: Printed for the Ray Society.)—This latest volume of the Ray Society's famous series of monographs is a detailed description of the habits, structure, life-history and zoological position of a group of animals which is very little known. The most familiar representatives of the *Tyroglyphidæ* are the ordinary cheesemites; but the family also includes some eleven other genera which swarm in countless myriads in flour, hay, wooden furniture and dead vegetable matter generally. Only a few of them reach $\frac{1}{50}$th of an inch in length, and many are considerably smaller. The little creatures here described are in many respects of very simple structure, for they possess no definite organs of respiration, circulation, sight, hearing or smell. They have, however, a marvellously delicate sense of touch. They are of comparatively active habits and are in no sense parasites. One of the most interesting parts of the book is that dealing with development. The *Tyroglyphidæ* pass through four well-marked stages: the egg, the six-legged larva, the eight-legged nymph and the adult. In the nymphal stage some genera assume a curious heteromorphous form known as *Hypopus*. The hypopi attach themselves to insects and other animals, and thus secure a very wide distribution. Even to those who are familiar with the refinements of modern biological methods this volume will appear a notable record of an amazing amount of technical skill and patient research. It is well illustrated by nineteen full-page plates.

"THE SACRED BEETLE: A POPULAR TREATISE ON EGYPTIAN SCARABS IN ART AND HISTORY." By John Ward, F.S.A. (John Murray.) 10s. 6d. net. It is well known that the beetles, now called *Scarabaeus* by entomologists, were regarded as sacred animals by the ancient Egyptians. It has been suggested that the habits of these insects in rolling about their balls of dung were considered as typical of the revolution of the heavenly bodies, while the re-appearance of the beetles after a sojourn underground may well have symbolised the resurrection of the dead which formed so important an article of the old Egyptian faith. The scarabs described and figured in a beautiful series of plates by Mr. Ward were representations of the sacred beetle usually cut out of steatite and bearing inscriptions on the lower flat face. Kings and great men had their peculiar scarabs, and these became the records of royal edicts, marriages or hunting expeditions. The oldest scarab figured is one of Neb-ka-ra, the First King of the Third Dynasty (probably B.C. 4212). The use of scarabs died out after the Persian Period (about 500 B.C.). Mr. Ward draws attention to the likeness between the old Egyptian "Kheper" whose hieroglyph was a scarabaeus, and the modern German "Käfer," our own Chafer, which is commonly applied to such insects of the sacred beetle's family as inhabit our islands, hardly, as Mr. Ward seems to think, to the sacred beetle itself. Probably the earliest of these "scarabs" were the oldest representations of insects made by man. At any rate, Mr. Ward's book cannot fail to interest the zoologist, the historian, and the theologian.

"A TEXT BOOK OF GEOLOGY." By Albert Perry Brigham, A.M., F.G.S.A., Professor of Geology in Colgate University. Pp x. and 478. (London: Hirschfeld Bros., Ltd. 1902.) This is an elementary text-book for American schools; and we may conclude, from the absence of the printer's name, that it has been imported ready printed in sheets into this country. Except for the interesting references to American examples and deposits, it would not find sufficient place in England beside the equally compact class-books of Geikie, Lapworth and Jukes-Browne. In the United States, moreover, physical geology and geography are exceptionally well represented in a handy form by Davis and Tarr, while that charming essay of a distinguished author, Heilprin's "Earth and its Story," must already hold a considerable field. Like its American competitors, the present book is well illustrated from actual examples; the scene of mountain-waste at Guttannen (p. 40), the unnamed delta on p. 68, the author's view of the source of the Aar (p. 102), and the glacial hills and lakelets (pp. 207 and 272), may be cited as of especial service. The book is simple throughout, and cannot lay claim to any novelty of method; but at the same time it is both clear and accurate. The progress of geology has been watched by the author, who has even given us on p. 322, quoted from Ruedemann, a "free-swimming colony" of Diplograptus, formed

of some twenty axes attached to a central float. There seems to us a lack of the personal element, or of appeal to the great workers of the past century, such as often imparts life to a description, and captures the interest of the beginner; but Professor Brigham's work, utilised by an inspiring teacher, will at least convey no false impressions. In saying this, we pass over the old old statement on p. 97 that *roches moutonnées* were so called from their resemblance to a flock of sheep, for here our author has the best of company. De Saussure was in reality struck by the resemblance of these rounded rocks to the mammillations of a fleece or wig. Probably in his desire to be popular, Professor Brigham speaks of the "Irish Elk" and maintains on p. 388 the familiar distinction between Goniatite, Ceratite, and Ammonite, an arrangement that gives Cerotites undue importance as a group-term equivalent to all the other Triassic Ammonites. Our author, like those before the days of Alpine exploration, ignores the Triassic Ammonites altogether.

A slip that seems worth correcting occurs on p. 197, where gypsum is spoken of as "the only important rock-forming compound of sulphur," "pyrites"—which certainly should be "pyrite" or "iron pyrites"—being given later. The composition of gypsum is not stated. Moreover, were crinoids (p. 325) so named "from their likeness to a lily"? On p. 55, the odd-looking technical word "talus" is usefully connected with "an ankle"; it may be well to note that the Low Latin form *talutum* was used also for a projection, and probably gave rise to the term "talus" in engineering and geology.

Altogether, for American readers, Professor Brigham's work is concise and useful, though it cannot be regarded as a contribution to knowledge.

## STUDIES IN THE BRITISH FLORA.

By R. LLOYD PRAEGER, B.A.

### III.—FERNS.

THE Ferns whose cool green fronds peep at us from the hedgerows or cluster in shady glens and on damp mountain-sides are an interesting race of plants, and high favourites with all nature-lovers. The differences which separate them from the Flowering Plants and place them, with their allies the Horsetails and Club-mosses, at the head of the vast army of Cryptogams or Flowerless Plants, consist chiefly in the lower type of the asexual generation (what we know as the *plant*) and the prolongation and independence of the sexual generation. In an ordinary Flowering Plant, too, the pause in vegetative growth, when the individual gives rise by means of the dissemination of seed to a number of new individuals, takes place after fertilization has been effected by the union of male and female elements in the flower. When the seed germinates, no cessation of vegetative life takes place until seed has been again formed subsequent to flowering. In the Ferns, on the other hand, the formation of "seed" and dissemination take place *before* the production of the male and female elements. The seed or spore grows into a

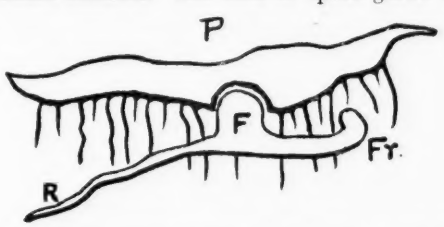



FIG. 1.—Section through a very young Fern. P, the prothallium, with root-hairs on under side. F, foot of young fern-plant, embedded in the hollow of the archegonium. R, first root, and Fr, first frond, of young fern-plant. Much enlarged.

*prothallium*—usually a minute green heart-shaped prostrate leaf-like growth, on the under side of which the male and female organs (*antheridia* and *archegonia*) are developed. The antheridia liberate a number of *antherozoids*, tiny coiled motile bodies, which twist about and swim in the surrounding moisture, and eventually fertilize the archegonium by fusion with the *ovum*, or egg-cell, which it contains. Fertilization being effected, the growth of the new plant from the ovum commences at once. The prothallium fades away, and the young fern increases in size, and generally lives for many years, producing on the under side of its green fronds abundance of spores, capable of again giving rise to the prothallium form. In other words, there is thus in Ferns a *distinct* alternation of

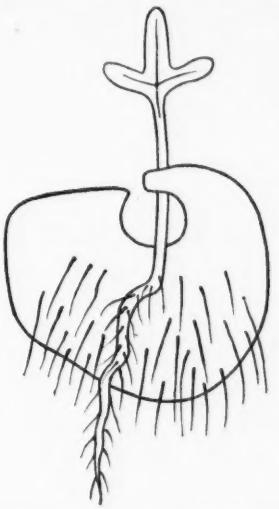


FIG 2.—Young Fern older than in Fig. 1, showing prothallium (under side), and first root and frond of fern-plant. Much enlarged.

generations. The *oophyte* is a minute and normally short-lived plant, while the *sporophyte* usually lives for many years, and sometimes, as in the Tree-ferns, attains very large dimensions. It will be noted that when a "fern" is spoken of, it is the asexual generation, or sporophyte, that is always meant. The non-botanical reader is asked to carefully note the incidents, as briefly sketched, of this life-cycle, in view of certain remarkable departures from it which will be considered towards the end of the present article.

So much for the life-history of Ferns. As regards their history on this earth, Ferns present an immensely long lineage, longer by far than the oldest of the Flowering Plants. They make their first appearance as fossils in Devonian rocks, amid their allies the Horsetails; and in the hot steaming forests of the Carboniferous Period, whose remains form our Coal-measures, they attained a wealth of variety and luxuriance that in the millions of years that succeeded has never again been equalled. Still, they form an important portion of the present vegetation of the globe, numbering, at a low computation, three thousand species, belonging to about sixty genera. Attaining their fullest development in the hot damp Carboniferous forests, they have ever since maintained their preference for heat and moisture. The vast bulk of the three thousand existing species cling to the Tropics, and among the forty-seven species which are found in our Islands, hardly one but seeks a damp and shady situation. To revert to a term used in my last article, Ferns are essentially *hygrophiles*—moisture-lovers—and the student of botanical geography will note how they increase in number as one passes from dry to wet regions—as one leaves the "Germanic" flora of East Anglia, for instance, for the "Atlantic" flora of Wales. Not one of our Ferns

is characteristic of sandy or gravelly ground. The Common Polypody selects walls, rocks and tree-trunks for its home, and most of the Spleenworts are wall-plants; in the case of the first, its fleshy, creeping stem stores up water and food for the dry season, while the latter send a network of roots deep into the stonework from the sheltered crevices which they choose for their abode. It may be noted also, that all the wall Ferns vegetate in spring and early summer, and even if completely shrivelled by summer drought, they lie dormant till autumn rains awake them: they possess enough of the impervious characters of xerophytes to prevent entire drying up of their root-stocks. The Bracken grows abundantly on sand-dunes, but its far-creeping rhizome lies deep buried in the sand, beyond the reach of summer suns. In the much-divided nature of their fronds, Ferns also show the characters of a damp-loving and shade-seeking ancestry; where compactness of growth to prevent excessive transpiration was unnecessary, and a spreading out to catch the maximum of light an advantage.

Ferns are classified according to the manner in which the spore-cases are arranged. Of the eight families into which living ferns have been divided, the *Polypodiaceæ*, characterized by the incomplete character of the *annulus*, or ring of thickened cells which encircles the wall of the stalked spore-case, is far the largest, and to it belong all our British ferns except the Filmy Ferns, which are the simplest forms, and the Royal Fern, Adder's-tongue and Moonwort, of which the last two belong to a strangely aberrant group.

Since form of stem determines style of growth, it is worth while considering this character in our British Ferns. We find a considerable variety of stem-forms. Of short, upright stems, such as characterise so many of our higher plants, we have a number of examples. These upright stems often elongate by degrees, as in the Male Fern, Lady Fern, Hart's-tongue. Very old specimens of the Male Fern, and one or two others, may have stems of one to two feet in length, resembling in miniature the Tree-ferns of the Tropics, which, however, belong to a family, *Cyatheaceæ*, unrepresented in our flora. These upright stems are much thickened by the persistence of the bases of the stalks of bygone fronds. In other species the stems are procumbent and slowly creeping; the Maidenhair, *Cystopteris fragilis*, and *Lastrea spinulosa*, furnish good examples. The Common Polypody and Killarney Fern have more rapidly creeping stems, which rest on the surface of the ground. The Polypody is remarkable among our Ferns for having its fronds articulated to the stem, so that they eventually drop off, leaving a scar. But the most far-creeping stems are those which grow below the surface of the ground. The most familiar example is the Bracken, whose vigorous branching stems cover whole mountain-sides with a forest of green fronds. In wind-excavated escarpments in sand-dunes, these black rhizomes, knotted with the stumps of old fronds, may be sometimes seen hanging twenty or thirty feet in length. The Oak and Beech Ferns, the Marsh Fern, Mountain Bladder Fern, and the two Filmy Ferns, have also subterranean creeping stems, and consequently form spreading colonies, instead of the close tufts caused by the occasional branching of upright stems.

To revert to those few British Ferns which are not members of the family *Polypodiaceæ*. The lovely Killarney Fern and the two Filmy Ferns belong to the *Hymenophyllaceæ*, which are the simplest in structure of the Ferns and show some affinities to the mosses. These species are essentially hygrophile. Their delicate pellucid fronds, formed of only a single layer of cells, shrivel at once in a dry atmosphere. They differ also from most of our Ferns in the fact that their fronds are not annual, but will last for a number of seasons. The fronds of *Hymenophyllum unilaterale* will even continue to grow for several years in succession; I have fronds nine inches in length, the result of three successive seasons' growth under close treatment. These delicate species usually seek deep shady dells, where the sun never penetrates; here they clothe damp rocks with their dark verdure, but in some parts of our Islands, as on the west coast of Ireland, the atmosphere is so charged with moisture that on a mountain-side facing north, the Filmy Ferns may form a constituent of the short spongy turf, freely exposed to the weather.

The only British representative of the *Osmundaceæ* is the well-known Royal Fern, *Osmunda regalis*, which needs no description here. Whereas in many of our British Ferns certain fronds produce no spores, but confine themselves to the process of assimilation, while others, whose chlorophyll-bearing area is restricted, bear spores, in the Royal Fern the upper portion of the fronds is set apart for the production of the fructification, the lower parts being expanded, green and leaf-like. But pinnæ may often be found in which every gradation from flat green barren pinnules to narrow fruit-covered ones is present. The remaining ferns, the Adder's-tongue and Moonwort, possess remarkable features. The prothallium, instead of being flat, green and aerial, is a subterranean colourless mass of tissue. The stem, likewise, is subterranean, and very short, sending up each year an aerial branch which divides into two, a spore-bearing portion and a barren leaf-like portion. In the arrangement of the young fronds, too, these plants depart from the almost invariable rule of Ferns, the parts being folded straight instead of coiled up. These Ferns likewise differ from their British allies in their habitat, since their home is in open pastures and heaths, the Adder's-tongue preferring the lowlands, the Moonwort the uplands.

As regards habitat and distribution, our Ferns exhibit a

Fig. 3.—Pinna of *Osmunda regalis*, showing transition from barren to fertile portions.

wide diversity. Though none of the species are aquatic, several of the *Lastreæ* frequent wet marshes, notably *L. Thelypteris*. Most of our Ferns are wood and glen plants; some, as already pointed out, seek rocks and walls. While the majority are lowland, many delight in the skirts of the mountains, and a few, notably the two species of *Woodsia* and the Holly Fern, are Arctic-Alpine plants. In opposition to these, the Maiden-hair and Killarney Fern are plants of markedly southern type. One, *Asplenium*

*marinum*, has its home along the sea-coast. Most, as already stated, are conspicuously hygrophile—lovers of damp air. The Hard Fern and Lady Fern are conspicuously calcifuge, the former especially pining in a limestone soil as rapidly as a Rhododendron; while the Limestone Polypody, the Scale Fern, and *Lastrea rigida* are particularly partial to limestone—strongly calcicole.

Our alpine and arctic ferns are found chiefly in Scotland, the southern and moisture-loving species in West England and Ireland. The calcicole species exhibit peculiarities of range, *Lastrea rigida* and *Polypodium Robertianum*, which are locally abundant on the limestone pavements of northern England, being altogether absent from the similar formation in Ireland, where, in the west, their place is taken by the Maiden-hair. The rock-loving Ferns, especially the calcicole Scale Fern, have had their range greatly extended by human civilization, on account of the building of walls of stone and lime, which form for them an eminently suitable home. But most Ferns are plants of thoroughly wild ground, and decrease with the spread of civilization.

As regards their leafy parts, all our Ferns, with the exception of the Adder's-tongue and Moonwort beforementioned, are arranged on a similar plan. A principal vein or midrib traverses the whole length of the frond, on each side of which the expanded green lamina is arranged symmetrically, the lower portion of the midrib being generally bare and forming a stalk (*stipe*). On the under side of the lamina the spores are produced. It is owing to the cutting and dividing of the lamina that our Ferns possess so much variety. In one species—the Hart's-tongue – the frond is undivided and strap-shaped; in the Common Polypody and Hard-fern it is divided into simple comb-like teeth. In the Male Fern, &c., these *pinnæ* are again cut down to their midribs into *pinnules*. And in the Bracken, Lady Fern, and others the pinnules are in their turn divided into *lobes*. The lower pinnæ in many species are the largest, giving the frond a triangular outline, and in some, as the Oak Fern, the lowest pair are so enlarged that the frond is ternate, consisting of three divisions of nearly equal size.

To return to the question of the reproduction of Ferns. Although their tiny spores are produced literally by the million, Ferns do not submit to artificial cultivation with anything like the readiness displayed by Flowering Plants. The reason is to be sought in their hygrophile proclivities. To raise Ferns from spores, a continuously damp atmosphere is necessary, and if the air is warm also, so much greater the chance of success. But even then the difficulties are not over, for the oophore or prothallium generation is so minute that the seedlings run risk of being smothered by the rich growth of algæ induced by the confined atmosphere. Those Ferns which have creeping stems may enlarge their area indefinitely by means of vegetative growth; and in some abnormal cases, British Ferns reproduce themselves by another vegetative process —namely by bulbils—little buds produced on some portion of the frond, which grow directly into fresh plants. Such bulbils are characteristic of many varieties of *Polystichum angulare*, and occur, though more rarely, on abnormal forms of the Hart's-tongue, Male Fern, Lady Fern, &c.

A much more curious and abnormal mode of reproduction has been brought to light in recent years. Let me recall the normal process in our common Ferns. Sporangia, or cases containing spores, are developed in groups or rows on the under surface of the frond. The spores, being liberated, give rise to small leaf-like prothallia, on the under surface of which male and female organs (antheridia and archegonia) are developed. When fertilization has taken place (which is effected by means of motile antherozoids), vegetative growth at once begins in the egg-cell of the archegonium, and a young fern is the result, the prothallium withering away. In 1868, a very beautiful variety of the Lady Fern was found wild in North Devon by Mr. R. Moule, in which the fronds were large and translucent, the ultimate divisions being very long, slender, and deeply cut. The fern was apparently barren, for though plenty of fructification was produced, no spores could be obtained, and in consequence, in 1883, only two divisions of the plant were in existence. In that year, Mr. G. B. Wollaston discovered in another variety of Lady Fern, that the place of the spore-cases was occupied by numerous bulbils, which were capable of forming new plants by direct vegetative growth. Mr C. T. Druery was led by this observation to examine the sporangia of var. *clarissima*, as the Devon form had been named, and found that they consisted of groups of strange flask-shaped bodies, which were quite unlike spore-cases. These were carefully planted in a seed-pan; they immediately commenced to grow at their tips, which expanded at length into perfect prothallia, which in due course produced male and female organs, and subsequently young fern-plants.* In other words, this remarkable fern was found to produce, not spore-cases and spores, but in place of them prothallia, and to pass from the asexual generation (or fern-plant) to the sexual generation (or prothallium) without the intervention of the spore. In the year following the announcement of this discovery, a still more remarkable phenomenon of a like nature was brought to notice.† Mr. Wollaston observed an abnormal growth proceeding from the tips of the pinnules of the variety *pulcherrimum* of *Polystichum angulare*—also a North Devon find. The tip was found to grow out into a delicate green ribbon, which eventually expanded and thickened into a fully-formed prothallium, on which were developed archegonia and antheridia. "This Polystichum," says Prof. Bower, "is thus an example of the formation of an expansion of *undoubted prothalloid nature* bearing sexual organs, by a process of purely vegetative outgrowth from the Fern-plant—that is, there is a transition in this case from the sporophore generation to the oophore by a vegetative growth, and without any connection with spores, or, indeed, with sporangia or sori. It may be regarded as

FIG. 4.—Prothalloid bodies occupying the place of sporangia in *Athyrium Filix fœmina*, var. *clarissima*. After Druery. Much enlarged.

FIG. 5.—Prothalloid body produced by outgrowth of veinlet of *P. angulare*, var. *pulcherrimum*, Wills. After Druery. Enlarged.

* Druery in *Journ. Linn. Soc.*, Botany, Vol. XXI. † Bower, *ibid*

a more complete example of *apospory* than that of *Athyrium Filix-fæmina*, var. *clarissima*."* Two years later, Mr. Druery subjected a different form of the var. *pulcherrimum* above-mentioned—in this second case a Dorsetshire find—to close culture, with the result that not only did the pinnule-tips produce such a number of prothallia that "the pinnæ were absolutely fringed with them," but prothalli also appeared which were produced in quite another manner. Certain veinlets rose out from the surface of the pinnules, and arching over, were prolonged into pendant pear-shaped bodies, which sent out root-hairs, and, under favourable conditions, grew into prothallia.† In 1892 Mr. Druery made another step by discovering prothalloid growth proceeding, not from any one part, but over the whole surface and edges of a seedling crested Male Fern, *Lastrea Pseudo-mas*, var. *cristata*, which, however, lost this prothallium-bearing character as it grew older.‡ In this variety, it should be pointed out, another abnormality of reproduction was already known to occur, namely, the production of the young fern-plant by purely vegetative growth from the prothallium, without the aid of sexual action (*apogamy*). So that in this Fern

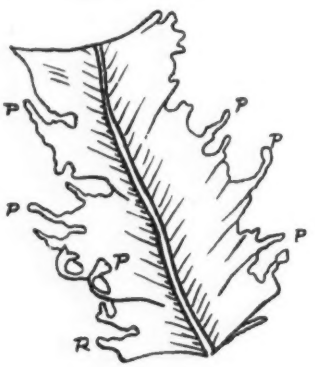



Fig. 6.—Portion of frond of *Scolopendrium vulgare*, var. *crispum Drummondæ*, showing production of prothallia (P, P) along the edge of the frond. Natural size. After Druery.

two remarkable short-cuts in reproduction occur, the sporophore sometimes growing direct from the oophore (by this the sexual organs are eliminated in the life-cycle of the plant), and the oophore sometimes growing direct from the sporophore (by which the spore is eliminated). Mr. Druery continued his investigations, and next announced§ an aposporous Hart's-tongue, a frilled variety, found many years before near Falmouth by Miss Drummond, in which prothalli were produced from the tips of the lobes, into which the margin of the frond is in this form divided. He also discovered another form of *clarissima* Lady Fern, which showed the phenomenon of apospory, not only in the fructification, but also at the apices of the divisions of the frond. Mr. E. J. Lowe,‖ in his experiments in prolonging the prothallium generation of Hart's-tongue, by continually subdividing the prothallia (in order to keep the two sexes apart), produced, when sexual action was at length allowed, some extraordinary little Hart's-tongues, of which the fronds were simply masses of prothalloid growth. A characteristic example of apospory occurs in a densely-crested form of the Lady Fern, *Athyrium Filix-fæmina*, var. *uncoglomeratum*, an offspring of var. *acrocladon*, which was found wild in Yorkshire in 1860. Dr. Stansfield observed that in the autumn of 1896, when the fronds were dying down, the extreme tips of their bushy crests remained green. He planted these, whereupon they kept growing, slowly unrolling and branching, and the tips eventually expanded into prothallia, which produced young fern-

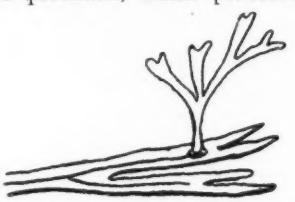


Fig. 7.—*Athyrium Filix-fæmina*, var. *uncoglomeratum*. Young plant arising by budding from prolonged tip of portion of the frond. Enlarged. After Stansfield.

plants by sexual action. Young plants were likewise produced by direct budding, both on the tips of the frond and on the prothallia, so that in this remarkable instance no less than three abnormal processes of reproduction were going on at the same time! *

Apospory in the forms described above is now known to occur in quite a number of Fern varieties of the kinds named above—plumose, crested, and *pulcherrimum* forms—which have been for many years known to be barren varieties, so far as the production of offspring by means of spores was concerned.

So it will be seen that to the normal alternation of generations in Ferns some very remarkable exceptions have been discovered, chiefly among wild British varieties, in which the parts of the frond are very much divided. The phenomenon has been noticed in *Athyrium*, *Polystichum*, *Scolopendrium*, *Lastrea*, and probably *Polypodium vulgare*, and to these may be added the Bracken, *Pteris aquilina*, of which an aposporous form has been found in the United

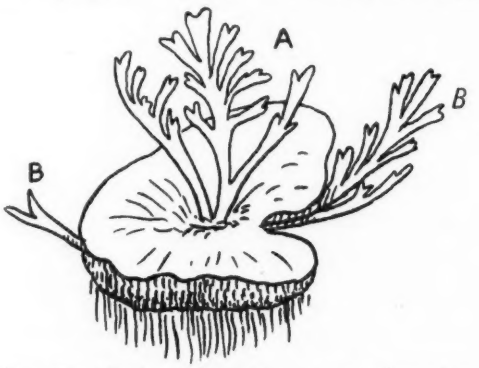



Fig. 8.—*Athyrium Filix-fæmina*, var. *unco-glomeratum*. Prothallium produced by vegetative growth from tip of portion of frond, bearing young plant (A) produced by budding on the surface of the prothallium and also young plants (B, B) produced by normal sexual action. Enlarged. After Stansfield.

States.† The curious outgrowths which result in prothallia may take place in the aborted fructification, on the tips of the pinnules or of crestings, from any portion of the margin or surface of the frond, or from the extremities of projecting veins. The production of these premature oophores appears to be much stimulated by cultivation in a close damp atmosphere—without which, indeed, the delicate prothallia, and the young fern-plants arising from

* *Loc. cit.* † Druery, *Journ. Linn. Soc*, Vol. XXII. ‡ *Journ. Linn. Soc.*, Vol. XXIX. § *Ibid*, Vol. XXX. ‖ *Ibid*, Vol. XXXII.

* Stansfield, in *Journ. Linn. Soc.*, Vol. XXXIV.
† Farlow, in *Annals of Botany*, Vol. II., p. 383, 1888.

them, would have absolutely no chance of life. It is suggested by Dr. Stansfield that apospory may be an atavic trait—"a character that may have been general or even universal in the infancy of the race. This idea is borne out to some extent by the fact that apospory is favoured by a uniformly humid atmosphere, a condition which probably prevailed in early geologic (say Silurian and Devonian) times."* A still more remarkable "short cut" has been detected recently by Mr. W. H. Lang, when experimenting with apogamous ferns. In a Carnarvonshire variety of the Broad Buckler Fern, *Lastrea dilatata*, var. *cristata gracilis*, and a much-branched variety of the Hart's-tongue, *Scolopendrium vulgare*, var. *ramulosissimum*, that observer discovered that sporangia were borne on the prothallia, thus cutting out the whole asexual or fern-plant generation.†

So, as Mr. Druery remarks in a recent‡ summing-up of the question, "it has been now demonstrated that in the sequence of spore, prothallus, antheridia, archegonia, fertilized seed and spore-bearer, every one of the steps, without exception, can be eliminated altogether; thus apospory cuts out the spore and even the spore-heap; bulbils on the fronds or elsewhere, cut out the prothallus; apogamy cuts out the antheridia, antherozoids, archegonia, and fertilized seed; and the spore-bearing prothallus cuts out the sporophore proper."

Note.—The Writer's best thanks are due to his friend, Mr. C. T. Druery, to Dr. F. W. Stansfield, and to the Council of the Linnean Society, for permission to reproduce or adapt Figs. 4 to 8, from the Society's *Journal*.

## Conducted by M. I. Cross.

Pond Collecting in May.—All the various pond organisms that die down in winter and in various ways produce protected germs to tide over this, for them, unsuitable season, will now have come to life again and begin to multiply at an increasing rate. Many kinds of Desmids should be found in shallow, mossy pools, or along the edge of rivulets. Among Protophyta and Protozoa the green spheres of *Volvox globator* will be found in many localities more or less abundantly, and the various kinds of Acineta should be looked for in quiet, undisturbed waters, where many kinds of free-swimming Infusoria will also be found.

Of Rotifera there are few species which may not be found in May. At one excursion of the Quekett Club to Totteridge in the middle of May forty different species were obtained. To mention only a few: *Notops brachionus*, one of the most attractive Rotifers, will have made its appearance, then various kinds of *Anuræa*, *Asplanchna*, *Brachionus*, *Coelopus*, *Cathypna*, *Diaschiza*, *Euchlanis*, *Furcularia*, *Mastigocerca*, *Metopidia*, *Pterodina*, *Synchaeta*, *Stephanops*, *Scaridium*; also *Stephanoceros eichhornii*, *Floscules*, *Melicerta*, and *Limnias* in abundance.

On rootlets of trees growing near the edge of ponds and lakes will probably be found various kinds of Polyzoa: *Fredericella Sultana*, *Paludicella* and *Plumatella repens*.

Attachable Mechanical Stages.—Many workers commence with a microscope of plain construction, and as the scope of their work increases find a mechanical stage a real necessity; especially is this the case with students. For ordinary biological and histological purposes a plain stage is not only sufficient but frequently found to be the most suitable, for with constant practice the fingers become educated to moving the object with accuracy and with a rapidity which could not well be attained with a mechanical stage. But when a $\frac{1}{12}$ in. oil immersion is added and systematic examination of a specimen over its entire surface is necessary, and not merely a general observation of its characteristics, the fingers fail to do what is needed. To meet such cases the attachable mechanical stage was devised, and judging by the many patterns that are offered, no small amount of ingenuity has been put into their construction. They unquestionably supply a need, but it cannot be too strongly emphasised how far inferior they are to a good mechanical stage built as a part of the microscope. The fewer detachable parts there are in the instrument the greater is the possibility of affording that rigidity which is such a prime necessity. Take any of the attachable mechanical stages, and none of them are really free from some defect; they have to be self-contained, and as the space in which they work is of necessity constricted, the bearings and fittings have to be of the lightest description, with the result that they rarely work truly, and if they receive a fall or knock are almost irremediably damaged. For any rack and pinion to engage and work responsively and without backlash the rack must be firmly bedded, and this cannot be accomplished so well in any other form as the fixed stage; no rack with its teeth set on end will ever be nearly so satisfactory. Further, in the attachable stage, when power is put into the milled-head, there is a tendency to shake or lift the attachment; this is an impossibility with the fixed stage.

In view of these facts it is worthy of consideration whether an attachable mechanical stage can be really accepted as a desirable addition to a microscope. The Continental makers, with the exception of Zeiss and Reichert, in their largest photographic stands provide the attachable patterns only, and where necessity has demanded the addition of a mechanical object carrier to a plain stage instrument, its use can be readily understood, but the price charged for them is so high that in nearly all English-made microscopes it is possible to exchange the plain stage for a good fixed mechanical pattern at the same or even less cost, and seeing that the modern fixed mechanical stages are made with a large plain surface on which the specimen can be manipulated with the fingers when low powers are employed, it is to be recommended that a fixed mechanical stage should at all times be obtained where possible, and the attachable form in cases of unavoidable necessity only.

Two-speed Fine Adjustment.—I called attention in the February number to a new two-speed fine adjustment which had been introduced by Messrs. R. & J. Beck, and another interesting device to secure the same result, but by other means, has been devised by Messrs. Watson & Sons. In this case, a single screw only is used, the differences of speed being obtained by two milled heads of different diameters, one being attached to the other. It is an old idea which has been used in micrometer gauges and spectroscopes and is here applied to the microscope.

If a large milled head be turned by the thumb and first finger, it will be found that the rotation is effected very slowly, but if that milled head were one-sixth of the size, it could be turned with six times the rapidity, and herein is the very simple explanation of the little application to Watson's fine adjustment.

The disadvantage of this arrangement is that work will be done by the fine adjustment which should more properly fall to the rackwork coarse adjustment, consequently, in course of time the single fine screw will be likely to show more signs of wear than the coarse screw used by Messrs. Beck for their slower speed, but in any case the action is so simple and effective that there is no reason why every microscope should not be provided with it.

Preparing Mycetozoa.—Mr. M. J. Cole gives the following instructions for mounting these specimens:—Most of these fungi can be mounted dry in glycerine jelly after soaking in equal parts of rectified spirit and glycerine to remove the air, but in those forms which possess lime granules in the capillitium—a character of importance in classification—the calcareous matter disappears when in glycerine in any form Where this is the case, place the specimens in absolute alcohol until all air is removed, then transfer to clove oil, and when clear, mount in Canada balsam.

* *Loc cit.* † *Proc. Roy. Soc.*, LX., p. 250, 1896. *Phil. Trans.*, CXC., B., p. 187, 1898. ‡ *Gardeners' Chronicle*, March 30, 1901.

Some specimens may, however, be rendered too transparent by the balsam, if so, mount them in a shallow cell in some neutral fluid, such as camphor water.

In their ripe condition they may also be mounted dry as opaque objects.

QUEKETT MICROSCOPICAL CLUB.—The list of excursions during the months from April to October, 1902, of the above club, has been sent to me, and those who may wish to become acquainted with practical collecting of micro specimens would do well to put themselves in communication with the Secretary of the Quekett Club at 20, Hanover Square, W., with a view to joining the club itself and taking part in these admirably arranged excursions.

## NOTES AND QUERIES.

*E. J. H.*—A new work entitled "The Foraminifera. an Introduction to the Study of the Protozoa," by F. Chapman, costing 9s., has just been published and it is likely that this may answer your purpose.

*T. H. A.*—The drawing you send is of a hair from the larva of Dermestes Beetle and the specimen is the larva itself. These hairs were at one time considered good test objects, and are in fact not to be despised for the purpose.

*Cleric.*—The best book for your purpose will be Lewis Wright's "Popular Hand-book to the Microscope," price 2s. 6d.

*C. H. C.*—In addition to the books named in my previous reply, correspondents recommend "A Text-book of Plant Diseases caused by Cryptogamic Parasites," by George Massee, of Kew, and Plowright's "Uredineæ and Ustilagineæ," Kegan Paul.

*O. T. E.*—MOUNTING POLLEN GRAINS.—Place these in alcohol and soak for a few days, then transfer to distilled water, then to hæmatoxylin for about fifteen minutes. Wash again in distilled water, dehydrate in alcohol, clear in clove oil and mount in Canada balsam. Carmine may be used instead of hæmatoxylin, if preferred.

*Miss Parish.*—MOUNTING DESMIDS.—Preserve in acetate of copper solution, and mount in a shallow cell in the same medium.

*Story, I. E.*—A note on the use of the collar correction of objectives will appear in an early number.

Correspondence is invited on the subject matters dealt with in these columns. Readers may see subjects from different points of view and their criticism will be welcomed.

*Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to* M. I. CROSS, KNOWLEDGE *Office*, 326, *High Holborn, W.C.*

## NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

THE GREAT SOUTHERN COMET OF 1901.—Prof. Theodor Bredikhine, of St. Petersburg, has written an interesting paper on the character and changes in the tail of this comet. The paper forms a useful contribution to cometary physics, and merits close attention from all those interested in the theory of comets. At the Cape Observatory some excellent photographs were taken of the recent comet, and these have been discussed by Prof. Bredikhine. They give indications that for several hours on April 23rd there occurred a violent eruption of material in an outward direction from the nucleus, and that subsequently to this discharge the nucleus seemed shorn of the usual envelopes. A secondary eruption, of much less prominence than the first, apparently took place on June 2nd, but the comet disappeared soon afterwards, and its further developments could not be traced. Prof. Bredikhine considers that the eruptive disturbance of April 23rd set up a rotatory motion in the nucleus in a similar direction to that of the orbital motion.

SCARCITY OF NEW COMETS.—The exceptional rarity of visible comets alluded to in the November number of KNOWLEDGE continues. During the whole of the past winter cometary observers have had practically nothing to examine in this field, yet in November, 1892, there were seven comets visible! Ordinary comet seekers have alighted upon no new objects since Giacobini at Nice announced his last discovery on 1900, December 20, which is sixteen months ago. This absence of comets is remarkable when we consider the large number of these bodies which were detected during the last quarter of the nineteenth century. It seems highly probable that many of these interesting and mysterious objects escape observation owing to the inadequate means taken to effect their discovery. It is to be hoped that in following years more observers will engage in this research, for, if it requires close application and no small amount of patience, it is almost certain to be successful in the end.

LARGE METEOR.—On the beautifully clear evening of March 23rd, at 7h. 25m., a fine meteor, nearly as brilliant as Venus, was seen by the writer at Bristol. It passed very slowly through Ursa Major, its flight being from 188° + 76° to 190° + 35°, and duration 4½ seconds. The nucleus was pear-shaped and yellowish; it left no enduring streak or train, but threw off a few red sparks as it rolled along. The probable radiant of the meteor was at 11° + 39° near the great nebula in Andromeda and its probable height 71 to 45 miles from above Worcester to Thame. It may have belonged to the same stream which furnished a pretty bright meteor on 1887, March 27, at 8h. 47m., and which was seen by Mr. T. W. Backhouse at Sunderland, and by the writer at Bristol. The radiant was at 11° + 35°, and the heights 59 to 55 miles, velocity 10 miles per second. Another fully recorded observation of the meteor of March 23rd last would be valuable, and enable its real path to be accurately determined. It was an unusually interesting object, and typical of that numerous class of fireballs which appear in the early evening, and are often directed in long slow flights from radiants at low altitudes in the western region of sky. Later on the same evening (March 23rd, 8h. 50m.) another very conspicuous meteor was noticed at Bristol by some casual observers, passing from left to right along the N.E. sky, but it has been impossible to ascertain any further particulars concerning it.

BRIGHT METEORS ON MARCH 29.—At 8h. 16m. p.m., Mr. J. Halton, of Manchester, observed a meteor rather brighter than Sirius, shooting towards the head of Serpens from between $\alpha$ and $\varepsilon$ Boötis. Motion rapid, duration about 1½ seconds. At 9h. 45m. another meteor appeared a few degrees under $\alpha$ Coronae and $\zeta$ Herculis, and travelled along from right to left in a direction almost parallel with those stars.

BRIGHT METEOR ON APRIL 10.—At 13h. 28m., the writer, at Bristol, observed a meteor brighter than 1st mag. crossing the star $\alpha$ Ophiuchi. It traversed a path of 10 degrees from 262½° + 16° to 251½° + 6°, and appeared to be rather foreshortened and not very far from its radiant, probably near 265° + 37°, 268° + 48°, or 276° + 69° Colour bluish-white, motion rather swift.

## THE FACE OF THE SKY FOR MAY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 4.35 A.M., and sets at 7.19 P.M. On the 31st he rises at 3.52 A.M., and sets at 8.3 P.M.

Sunspots are infrequent, but there are indications that the abnormally long period of minimum is drawing to a close and occasional spots may be looked for. There is a partial eclipse of the sun on the 7th, but wholly invisible in this country though visible in New Zealand and the South Pacific Ocean.

THE MOON:—

| | Phases. | h. m. |
|---|---|---|
| May 7 | ● New Moon | 10 45 P.M. |
| ,, 14 | ☽ First Quarter | 1 40 P.M. |
| ,, 22 | ○ Full Moon | 10 46 A.M. |
| ,, 30 | ☾ Last Quarter | 12 0 NOON. |

There are only two occultations conveniently observable this month; there is, however, a *near approach* of the moon to $\alpha$ Librae; the following are the particulars:—

| Date. | Name. | Magnitude. | Disappearance. Mean Time. | Disappearance. Angle from N. Point. | Disappearance. Angle from Vertex. | Reappearance. Mean Time. | Reappearance. Angle from N. Point. | Reappearance. Angle from Vertex. | Moon's Age. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | ° | ° | | ° | ° | d. h. |
| May 12 | 12 Cancri | 6·5 | 10 37 P.M. | 181 | 141 | 10 51 P.M. | 211 | 172 | 5 0 |
| ,, 15 | 36 Sextantis | 6·5 | 9 19 P.M. | 108 | 84 | 10 30 P.M. | 301 | 268 | 7 23 |
| ,, 21 | $\alpha$ Librae | 3·0 | 1 18 A.M. | 12 | 350 | —— | — | — | 14 3 |

The Planets.—Mercury is an evening star in Taurus, and after the first few days is well placed for observation. On the 28th, he attains his greatest easterly elongation of 23° 3′, and is situated about 2° north of 1 Geminorum; on this date the planet remains above the horizon until shortly after 10 P.M., or more than two hours after the sun has set.

Venus is a morning star in Pisces, she forms a conspicuous object in the morning sky shortly before sunrise, rising about 1h. 20m. in advance of the sun. During the month the apparent diameter diminishes from 23″·0 to 17″·4, and about the middle of the month the illuminated portion of her disc is 0·589 and answers to the appearance of the moon 8 days old.

Mars is practically unobservable, as he rises only about half-an-hour previous to the sun.

Jupiter is still in Capricornus, rising on the 1st at 2.5 A.M., and on the 31st at 12.11 A.M. His path is a short easterly one near to ι Capricorni. The apparent diameter is increasing, being 35″·8 on the 1st, and 39″·4 on the 31st. He is in quadrature with the sun on the 7th.

Saturn is also a morning star, rising on the 1st at 1.15 A.M., and on the 31st at 11.12 P.M. The planet describes a short looped path in Sagittarius, reaching the stationary point on the 8th. The apparent diameter of the planet is about 16″·0, whilst that of the outer major and minor axes of the ring are 40″·7 and 14″·8 respectively; the northern surface of the ring is presented to us.

Uranus remains in the most southerly part of Ophiuchus near 44 or *b* Ophiuchi. At the beginning of the month he crosses the meridian at 2.43 A.M., whilst on the 31st he crosses at 12 45 A.M.

Neptune is practically out of range, being rather low down in the north-west and lost in the strong twilight.

The Stars.—About 10 P.M. at the middle of the month Ursa Major will be nearly overhead; Arcturus a little east of south, and Spica Virginis on the meridian; Leo in the south-west, and Gemini in the north-west; Cygnus in the north-east; Vega high up in the east; Scorpio rising in the south-east.

## Chess Column.

By C. D. Locock, B.A.

**Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.**

### Solutions of April Problems.

(By C. C. W. Sumner.)

No. 1.

[We beg to supplement the composer's apologies for this unfortunate problem. The author's intention was 1. R to QB3, but there is a mate in one move, besides two other solutions by 1. Q to Kt3, and 1. Kt to B3ch.]

No. 2.

1. Q to Q4, and mates next move.

No. 3.

1. R to R4, and mates next move.

Correct Solutions of the three problems received from W. de P. Crousaz, W. Nash, Alpha, J. M. K., H. S. Brandreth, G. W. Middleton, Black Knight, G. A. Forde (Captain), C. D. Brown, F. Dennis, C. Johnston, G. Woodcock, A. C. Challenger.

Of No. 1 and No. 3, from H. Boyes.

Of No. 1 and No. 2, from H. H. S. (Teddington), Major Nangle.

*Major Nangle.*—In No. 3, if 1. R to QKt3, K moves and escapes.

*H. H. S.*—If 1. R × Kt, K moves.

*W. Harris.*—A dual mate in a two-move problem will not count. But no two-move problems will be published this year.

*Composer of "White Bishop."*—Problem withdrawn as requested.

*Vox Australis.*—You may have seen by now that the Knight's attempt to "perform the feat off his own bat" (January four-mover) is defeated by Black's device for obtaining a stale-mate position.

*C. C. W. Sumner.*—Many thanks for the revised position; I regret that there is no more space for two-move problems this year. But if you send it elsewhere, I should recommend you to examine the effect of 1. R × B.

*Composer of "All's well," etc.*—The problem must take its chance as to the date of its appearance. You will see that it is not drawn for publication this month.

*H. B. Dudley.*—I much regret that, as you sent your name and address, instead of the necessary motto and *sealed* name and address, your problem cannot appear in the tourney.

*Composer of "Donabo atque vincam."*—Please see the reply above. Apart from this I think you will find that the problem has at least two other solutions (1. R to B6ch, and 1. Kt to K5ch). With so much hostile force in the neighbourhood of the Black King I do not think that you will succeed in making the problem sound.

*Moha Shaida Ali Khan.*—I regret that I am compelled to exclude the four problems on the ground that the composer's names appear on them. In addition to this they arrived two days too late. The one marked No. 3 is, I think, by far the best, and I should recommend the composer to enter it in some other competition. The others, though all have sacrificial keys, are not of the kind preferred by English Tournament judges.

*Composer of "Post tenebras lux."*—Your problem has three solutions in two moves, and must be excluded, therefore, as "obviously unsound."

### PROBLEM TOURNEY.

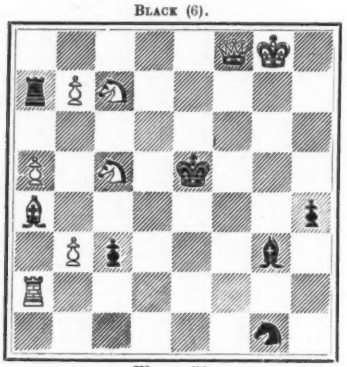
Additional Tourney Problems Received.—"Ariadne," "Per Aspera ad Ardua," "Algol," "Vega," "Brutum Fulmen," "With how much labour," etc. "Poor Pink," "Leonard," "Weighty," "Circumstances alter Cases," "Inter pocula," "Possibilities," "Knowledge rather than choice gold," "By indirection find direction out," "Variety charms," "Three steps and a shuffle off," "Fort nachanand," "Without Hope," "Ben trovato," "Aller güten Dinge sind drei," "All's well that ends well." Seven others received cannot be entered owing to non-compliance with the rules, or, in one case, obvious unsoundness. It is possible that I may find others ineligible on this last account; but if all survive a very cursory examination the total number of accepted entries (including eight previously acknowledged) will be twenty-nine, a very satisfactory number. In order to get the result published within a year it will be necessary to print three problems each month. The order of publication will be decided by lot, and this month the lot has fallen on the following:—

## PROBLEMS.

### No. 1.

"Per Aspera ad Ardua."

BLACK (6).



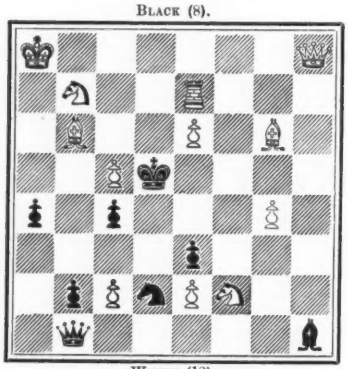
WHITE (9).

White mates in three moves.

### No. 2.

"Fort nachanand."

BLACK (8).



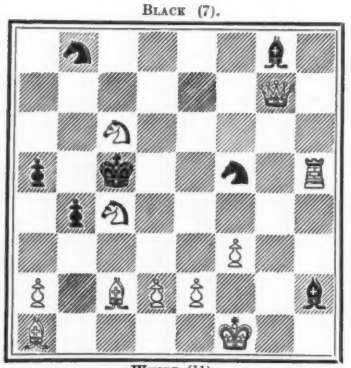
WHITE (12).

White mates in three moves.

### No. 3.

"Algol."

BLACK (7).



WHITE (11).

White mates in three moves.

Solvers are reminded that those who solve correctly every problem in the tourney will be entitled to act as preliminary judges. It is as well to explain that by "solving a problem correctly" I mean giving the correct key (if there is one and only one), *and no other*. But no solver will be disqualified from judging on the ground of failure in a problem which proves either incapable of solution, or capable of more than one solution. The proviso of solving every problem correctly was clearly only intended to ensure that the preliminary judges had appreciated the merits of every problem which could have *any chance of success*; and this end is met by limiting the proviso to the case of sound problems. I need hardly add that failure in duals will not be a ground for disqualification.

### SOLUTION TOURNEY.

This begins with the problems printed above, and will continue to the end of the year. During the publication of *Tourney* Problems duals will count, as explained last month. Solutions must bear postmark of the *issuing* office *not later than* the 10th day of the month of publication. I regret that the time for solution cannot be extended; but the task of examining claims for incorrect solutions, second solutions, duals, etc., involves considerable labour, and this page goes to the printer before the middle of the month.

## CHESS INTELLIGENCE.

The Inter-University Match took place at the British Chess Club on March 21st, and resulted in a draw. The score is as under:—

| OXFORD UNIVERSITY C.C. | | CAMBRIDGE UNIVERSITY C.C. | |
|---|---|---|---|
| Mr. W. M. Grundy, All Souls | 0 | Mr. H. A. Webb, Trinity ... | 1 |
| Mr. H. F. Davidson, Exeter... | 1 | Mr. F. W. Clarke, Pembroke | 0 |
| Mr. H. D. Roome, Merton ... | 1 | Mr. B. Goulding-Brown, Trinity | 0 |
| Mr. J. R. W. Robinson, New College | 0 | Mr. H. Bateman, Trinity ... | 1 |
| Mr. A. C. Ernsthausen, Balliol | 0 | Mr. A. C. Prichard, Queen's... | 1 |
| Mr. H. Taylor, Balliol ... ... | 1 | Mr. H. A. Stead, Emmanuel... | 0 |
| Mr. G. Walker, University... | ½ | Mr. M. Rittenberg, Caius ... | ½ |
| | 3½ | | 3½ |

On the following day Lancashire defeated Yorkshire (30 aside) at Manchester by 17½ games to 12½.

The brilliancy prize in the recent Monte Carlo Tournament has been awarded to Mr. James Mason for his game with Mr. Napier.

Mr. W. Ward is the winner of the City of London Club Championship this season. Mr. D. Y. Mills, for the second time, I believe, in the course of his career, has failed to win the Championship of Scotland.

The *Hampstead and Highgate Express* announces its fifth tourney for two-move problems. Entries to be made before May 1st. The first prize is one guinea, and half-a-dozen other prizes, of chess books, are also offered.

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